The University of Alberta
Printing Department
Edmonton, Alberta

Graduate Studen

THE UNIVERSITY OF ALBERTA

DENSITY OF BUS ROUTES IN NORTH EDMONTON

by

© JOHN WILLIAM GILL

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

DEPARTMENT OF CIVIL ENGINEERING

EDMONTON, ALBERTA

Fall 1969

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled DENSITY OF BUS ROUTES IN NORTH EDMONTON submitted by JOHN WILLIAM GILL in partial fulfilment of the requirements for the degree of Master of Science.

ABSTRACT

This thesis studies how travel time ratio, travel time difference, bus running time only, excess bus time, total bus travel time, population distribution and house sale value, affect the location of bus routes. The procedure used was to establish relationships between mode split and each factor, for the existing bus network, and then apply the relationships to two proposed bus networks in the same area.

The linear regression technique was used to establish these relationships and only relationships significant at the 5% level or better were considered.

Two methods were used to find bus travel time factors. The first method, previously established by Halls1968, found the time from the centroid of the origin zone to the centroid of the destination zone, while the second method averaged the time between all the bus stops in the origin zone to all the bus stops in the destination zone. The walking to the bus stop time for the first method considered time to walk from the zone centroid to the closest bus stop and waiting time was half the schedule headway or a maximum of five minutes. The second method determined walking and waiting time from an interview survey. The results obtained from each method were also compared.

Although population distribution did not form a statistically significant relationship with mode split, it was useful in establishing a measure of efficiency of a bus route. This measure of efficiency considered total population of the zone, population within walking distance to the bus stop and bus route street miles.

Travel time ratio and travel time difference were the only factors to form statistically significant relationships with mode split, for each of the destination zones considered.

ACKNOWLEDGEMENTS

The author wishes to express his appreciation to Associate Professor J.J. Bakker of the Department of Civil Engineering at the University of Alberta, Edmonton, for his guidance throughout this study.

Appreciation is extended to Mr. A.R. Ross of the Edmonton Transit System for making available the data from which the existing transit network was developed.

The author also wishes to acknowledge the financial assistance of the National Research Council toward this study.

The patience and understanding of my wife, Rosemarie, was also very much appreciated.

TABLE OF CONTENTS

TABLE OF CONTENTS (cont')

LIST OF TABLES

LIST OF TABLES (cont')

LIST OF TABLES (cont')

LIST OF FIGURES

LIST OF FIGURES (cont')

LIST OF FIGURES (cont')

CHAPTER I

INTRODUCTION

The choice of route location for transportation systems plays a vital part in the success and efficiency of those systems. While this general principle applies to all forms of transportation, this thesis will only be concerned with bus transit.

The traffic congestion in North American cities to-day, particularly during the peak hours, demonstrates that road capacity is having difficulty keeping pace with travel demand. The governments could increase the rate of road construction, but this would probably require an increase in taxes and other road user charges.

A means of relieving some of this congestion is to attract people to other modes of transportation, such as bus transit and rapid transit, which have a higher person carrying capacity than the automobile.

During the last couple of decades, however, there has been a decline in the number of people carried on these modes of transportation, therefore research is needed to-day to determine what factors people consider, when they have alternative modes of transportation from which to choose.

LIMITATIONS

This thesis is concerned only with bus transit as an alternative form of transportation. The attributes of bus transit upon which emphasis will be placed are those factors affecting the location of bus routes. While many of the principles and procedures adopted could be applied to any location, only that part of Edmonton defined by the boundaries of the

Northern Alberta Railway's tracks to the west, 127th Avenue to the south, Canadian National Railway's tracks to the east and the City Limits to the north, will be considered in detail (FIGURE 1).

The area is characterized by the fact that it is situated in a location of rapid residential expansion for the City of Edmonton. The major land use type is single family dwellings which constitute about 75% of the dwelling units in the area.

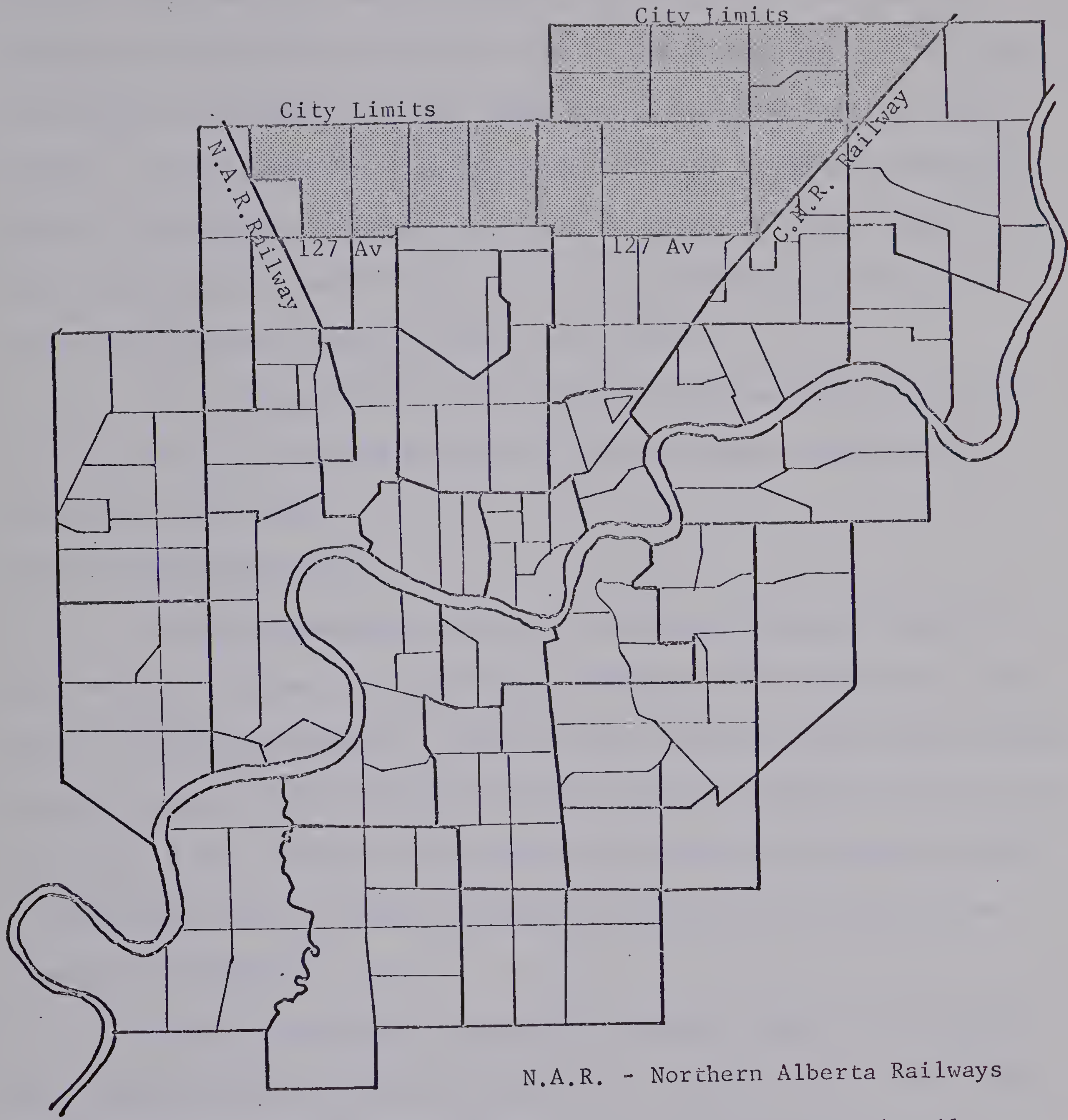
The area was considered to be useful for this study because of the different bus route locations that were possible and that the present spacing of bus routes either side of 97th Street is different. If at any future date it was decided to test some of the results of this thesis then it would be possible to introduce the proposed bus routes without overcoming any physical constraints.

The study has not only been confined to a particular part of the city, it has also been confined to a particular time of the day; that is the morning peak period, as the greatest congestion is experienced during this period. The data collected was for only this period and for those trips destined for the Central Business District (C.B.D.)

STATEMENT OF THE PROBLEM

The aim of this thesis is to investigate the relationship between bus route location, mode split, total travel time factors, excess time factors, and population within walking distance to the bus stop and subsequently to determine whether these relationships could be used to recommend the location of a particular bus route. Three bus route locations were considered in the analysis.

The data used have been 1967 auto times, and 1964 and 1969 bus times. From information supplied by the Edmonton transit authorities it



N.A.R. - Northern Alberta Railways

C.N.R. - Canadian National Railways

STUDY AREA

FIGURE 1

was found that in the areas under investigation the 1964, 1967 and 1969 transit times had not changed, although there had been some route relocation in the C.B.D. to allow for the one-way street system. The 1969 bus times were obtained through riding checks on routes north of 127th Avenue. It was found that schedule times for most of these routes had been in operation since either July 1967 or September 1968. Those routes whose schedules had been in operation since September were adjusted to agree with schedule times in effect in July 1967.

The waiting time at the bus stop and walking time to and from the bus stop were obtained through an interview survey specially conducted for this study.

REVIEW OF PREVIOUS WORK

Two previous theses have been presented concerning Edmonton's bus and car networks. In 1967, Rhyason (RHYASON 1967) presented a thesis which investigated changes in travel pattern with time and transit service changes, and in 1968, Halls (HALLS 1968) presented a thesis concerned with development of a technique for predicting the operational characteristics of a possible transit system that would be required to attain various levels of ridership.

Rhyason used data from the 1961 and 1964 origin - destination data from the City of Edmonton Metropolitan transportation study traffic zones, 1961 auto travel times from M.E.T.S. and 1961 and 1964 transit times. He also assumed that 1964 auto travel times were the same as the 1961 auto travel times because there had been no major changes in the road network. This assumption proved inaccurate so he had to develop a bridge penalty for people coming from the south side of the North Saskatchewan River to the C.B.D.

The data Rhyason collected for 1964 transit times was very useful for this study. The conclusions reached by Rhyason were,

a) The radical changes in transit routes did not affect the modal split relationships even though they did result in an increased modal split by reducing travel time. Thus the effect of transit changes can be measured using the mode split relationships.

b) Economic status and relative travel times are the chief factors affecting the choice of mode in Edmonton.

c) The modal split relationships in Edmonton are dependent on the area of employment within the C.B.D.

d) Parking plays an important role in mode split.

e) House sale value, which is easily obtained in Edmonton, can be used as a reliable measure of economic status.

f) Relative travel time can be measured with equal reliability by both travel time difference and travel time ratio.

Halls' thesis was concerned with developing a computer program which would trace the shortest path in a transportation network, between a given origin and destination. His thesis was mainly concerned with developing it for the Edmonton transit network using 1964 travel times. This program was found to be very useful in this thesis for finding the minimum travel time and route for auto trips from selected zone centroids to destination centroids in the C.B.D.

The recommendations made in his thesis were,

a) "Test networks should have the centroids located <u>off</u> the network, connected to it by dummy links representing the portions of the excess travel time which occur at the

beginning of the trip. This would simplify the testing of alternatives."

b) "Future work to confirm the value of reiteration of mode split relationships for transit network analysis should be carried out. These future analyses should consider two aspects in addition to excess speed.

   (i) Excess travel time. The possibility of reducing total trip time by reducing waiting time and/or eliminating transfers should be considered prior to analysis of operating speed.

   (ii) Actual Ridership. The actual number of riders who would benefit by any proposed change should be considered relative to the cost of any suggested improvement."

CHAPTER II

THEORY

The theory being presented to compare different locations of bus routes was adopted from an idea that every bus stop had a theoretical level of service and that the level of service was related to mode split (Rhyason and Halls). Level of service, as used here, means either travel time ratio or travel time difference.

The mode split also depends on the mode opportunity, because if there is no opportunity for people to use that mode, the mode split must necessarily be zero.

The potential number of people who will use any particular bus stop are those people living closer to that bus stop than any other bus stop. Hence from these people it could be possible to determine the number of people who use either the bus, the car, or any other mode of transport. From this information it would be possible to calculate a mode split for that bus stop. For this particular bus stop it would also be possible to determine bus excess time, average bus running times, car excess times, average car running times and the distribution and density of the dwelling units around the bus stop. If this information could be collected from many bus stops and the relationship between level of service and mode split could be established, it would be possible to predict approximately how many people would use the bus, when the location of a new bus stop was being considered.

It was realised that mode split may have statistically

significant relationships with other travel time factors or population distribution factors, therefore instead of using level of service as the main determinant, bus excess time, bus running time only, total bus travel time and population density ratio were also considered. The elements of bus excess time such as waiting and transfer time, depend on the frequency of service unless the schedule is known and walking time depends on the spacing of bus routes.

Each of the above factors have been given equal weight, as it was beyond the scope of this thesis to determine people's attitudes to the individual factors of total travel time. People may evaluate trips of equal travel time differently depending on whether the bus is express or makes frequent stops to pick up passengers, they may give more weight to waiting and transfer time than to walking time or actual travel time.

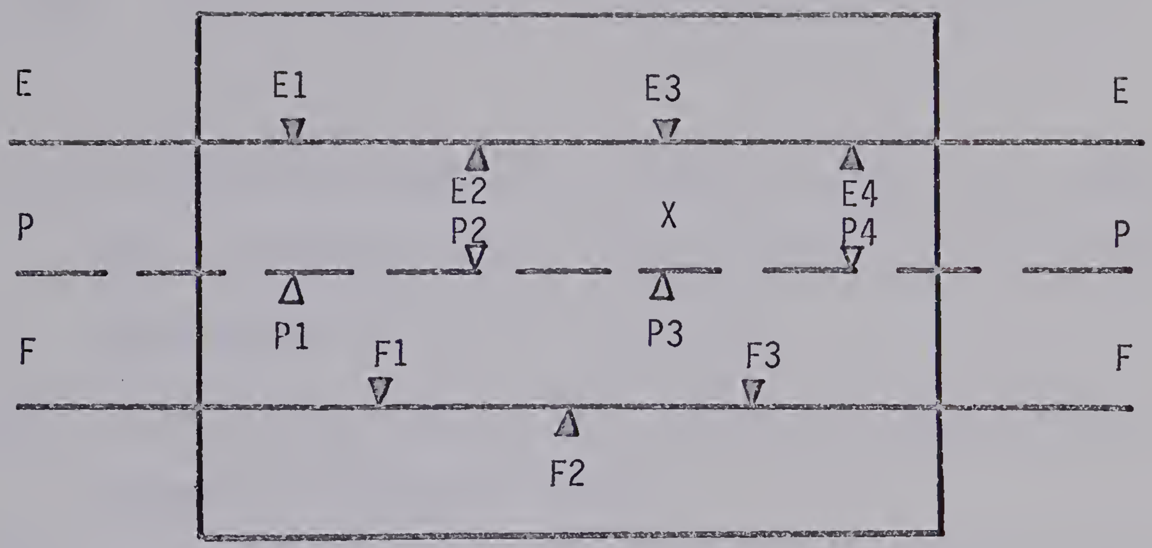
Instead of comparing bus stops on different bus routes, the intention was to compare traffic zones and see how the characteristics of each traffic zone was affected by placing bus routes in different locations.

Take for example, the hypothetical traffic zone shown in FIGURE 2, the line E-E, and F-F, represent existing bus routes and P-P represents a proposed bus route. The bus stops on each bus route are denoted by E1, E2 --E4 or F1, F2, F3 or P1, P2 -- P4 and "X" is the zone centroid (see Chapter III for discussion on the location of zone centroids.)

The bus route which provides the optimum service, would be located so that total travel time, that is excess time plus actual

travel time, is a minimum and the index "R" (see TABLE III-2), concerning population within walking distance to the bus stop and the route street miles travelled by the bus, is a maximum.

The present theory for comparing the locations of bus routes uses the zone centroid to determine minimum travel time, from each origin traffic zone to destination traffic zone, while the theory presented here, refers only to bus stops. To compare the characteristics of existing bus routes EE and FF, with the proposed route PP, for example, the level of service (or whatever similar factor is being considered) of the traffic zones for each bus route could be obtained by finding the level of service for each bus stop on that route and then finding their average value.



EE Existing Bus Route.

FF " " "

PP Proposed Bus Route.

X Zone Centroid

HYPOTHETICAL TRAFFIC ZONE WITH BUS STOPS

FIGURE 2

CHAPTER III

PROCEDURE

To use the method discussed at the end of the previous chapter, to compare the characteristics of different bus route locations would require more time than there is available, hence, that method was slightly revised. Each of the travel time factors were obtained as follows;

(i) Bus times were measured from each bus stop in the origin zones to each bus stop in the destination zones by actually riding the buses on each bus route.

(ii) Car times were measured from centroid of origin zones to centroid of destination zones.

(iii) Bus excess times were obtained from an interview survey, and the same figures were used for all zones north of 127th Avenue.

(iv) Car excess times were taken directly from Rhyason's thesis.

This method (designated the Field Method) was only used to establish car and bus travel times for the ten zones north of 127th Avenue. Halls' Minimum Path Method of calculating car and bus travel times was also used for these ten zones, however 25 additional zones were selected from the north side of the North Saskatchewan River to obtain a larger range of house sale values as well as improve the accuracy of the "mode-split" - "level of service" relationships.

The economic status of each traffic zone was established through the correlation that Rhyason found existed between level of income and average house sale value.

MODE SPLIT EQUATIONS.

The factors being investigated for their effect on different bus route locations have been derived from the data discussed in the next chapter. The factors are,

(i) Travel Time Ratio.

(ii) Travel Time Difference.

(iii) Bus Running Time Only.

(iv) Excess Bus Time.

(v) Total Bus Travel Time.

(vi) Population Distribution.

(vii) Mode Split.

(viii) House Sale Value.

The bus travel time factors ((i), (ii), (iii), (iv), (v)) were derived by two methods, the "Minimum Path Method" and the "Field Method", and since these methods were derived independent of each other, an opportunity was available to compare their results and examine their effects on different bus route locations.

For the traffic zones, from which bus and car times were calculated, graphs were plotted of mode split against each of the above factors. For the 35 zones, whose bus and car times had also been calculated using Halls' Minimum Path Method, the graphs were plotted for different groups and ranges of house sale values (TABLE III-1) to determine if the relationships were affected by economic status of the area. This procedure was not used, however, for the ten zones north of 127th Avenue whose bus and car times were calculated using the Field Method, as the sample size for each range of house sale values would have been too small.

TABLE III-1

GROUPS AND RANGES OF 1967 HOUSE SALE VALUES

Group	Range	House Sale Value
1	1	< $13,000
	2	$13,000 to $15,000
	3	> $15,000
2	1	> $13,000
3	1	All Values.

The range of house sale values in GROUP 1 was used because it roughly divided the 35 traffic zones into three (3) equal ranges of house sale value, and the minimum house sale value for the traffic zones north of 127th Avenue was $13,325.

For every graph that was plotted a regression analysis was performed, to test the statistical significance of each regression line. The regression analysis was performed by a program obtained from the University of Alberta, Department of Computing Science Program Library.. The program was titled "Simple Correlation and Plotting Package" (Number CS022) and was written by V.E. Yanda, of that department.

From the correlation coefficient calculated for each regression line, and the number of observations, the statistical significance could be found using statistical tables. The tables only enabled the 5% or 1% level of significance to be found.

The term significance is used in the statistical sense of the word and means, here, the probability of having drawn the wrong conclusion. A 1% (percent) level of significance means that there is a

one percent chance that the relationship represented by the regression line is wrong.

FIGURE 3 shows the graph and the results of the regression analysis, for mode split versus travel time difference, for the case when the travel time difference was determined using the "Minimum Path Method", the destination zone was "0010" and the range of house sale values was, greater than $13,000 or Group 2, Range 1 (TABLE III-1).

The results of the regression analysis show that the linear regression line $Y = A + BX$ has $A = 53.9165$, $B = -0.925360$, the statistical T value = -2.77 (this is meaningless here), the number of observations N = 24, and the regression coefficient R = -0.508. The graphs for mode split versus each of the other travel time factors, for which a significant relationship existed, are shown in APPENDIX D.

By substituting the appropriate travel time factor for a particular origin zone (such as travel time difference) into the linear regression equation, the corresponding mode split for that zone could be obtained. The mode splits for each zone using this method were plotted on a graph of mode split versus origin zone. FIGURE 4 is the graph for proposed bus routes P and EP for destination zone "0010". The letters "F.M." and "M.P.M", mean "Field Method" and "Minimum Path Method" respectively, and stand for the method used to calculate bus and car times. The graphs for each of the other travel time factors, resulting from the regression analysis are shown in APPENDIX D.

APPENDIX C, TABLES C1 to C7 list the factors used for the regression analysis. TABLES C1 to C4 list the factors for the 35 traffic zones whose bus times were calculated using the "Minimum Path

MODE SPLIT V'S TRAVEL TIME DIFFERENCE

PROGRAM V1

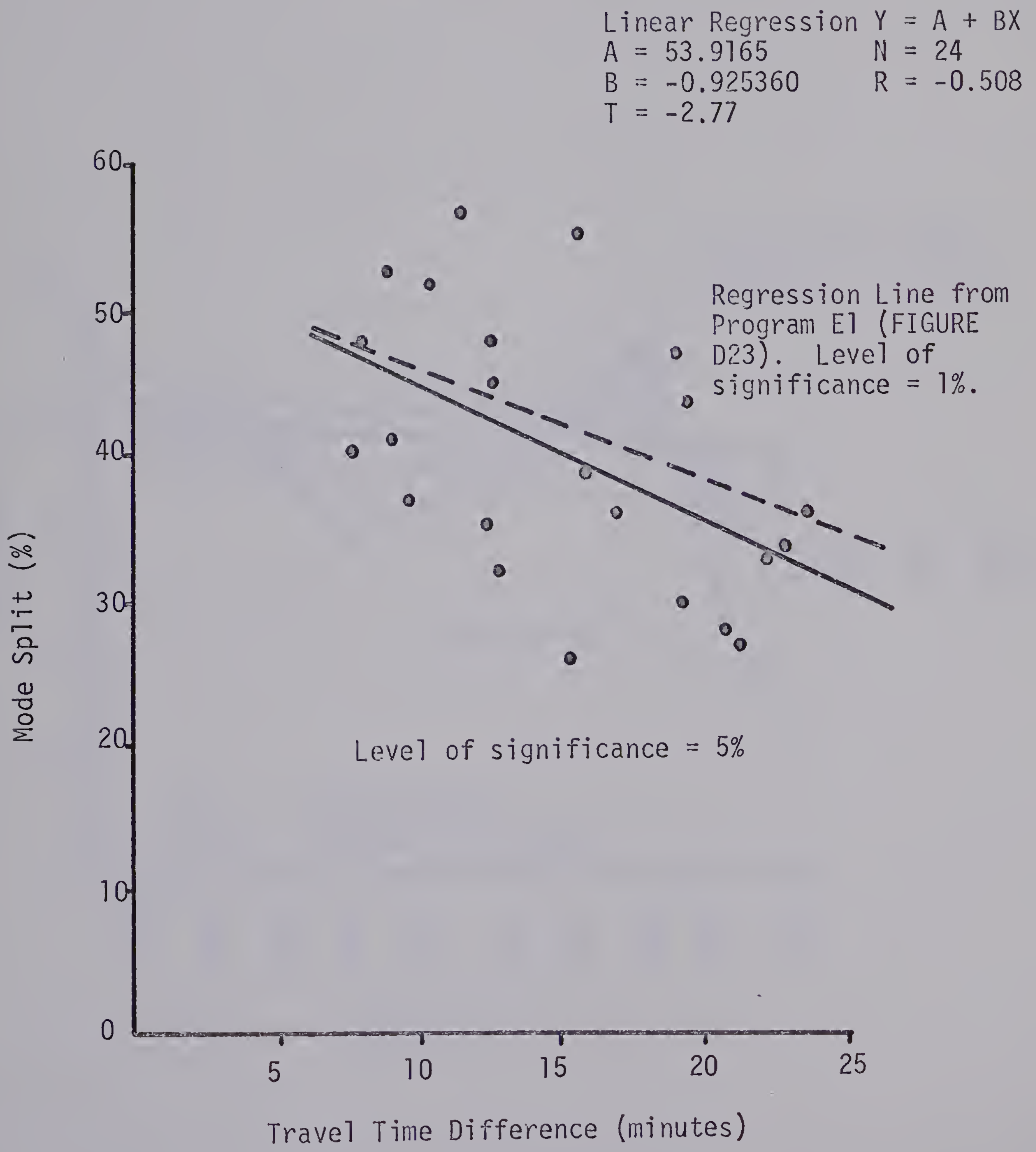


FIGURE 3

DESTINATION ZONE "0010"

"TRAVEL TIME DIFFERENCE"

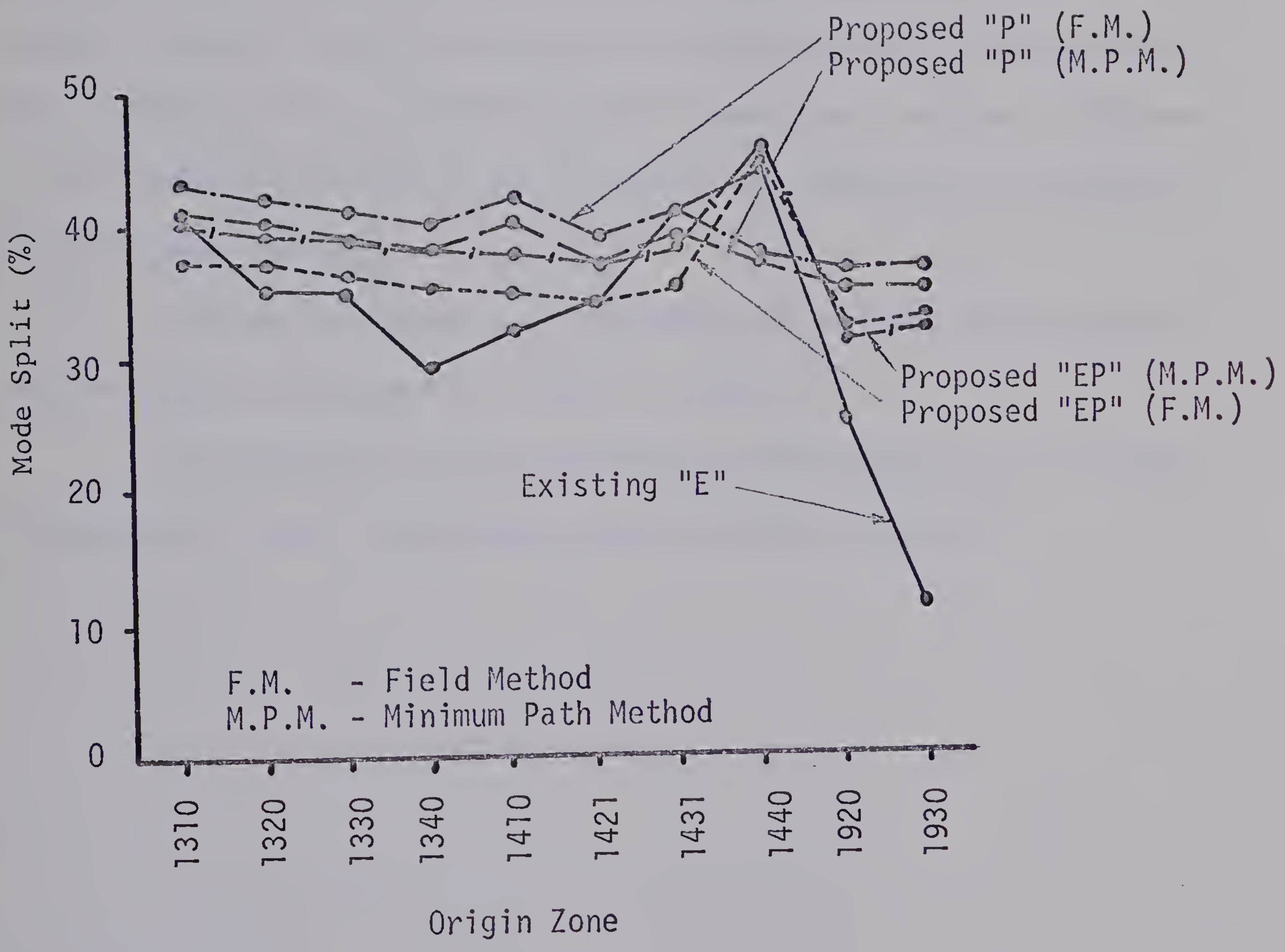


FIGURE 4

Method", while TABLES C5 to C7 list the factors for the traffic zones north of 127th Avenue, whose bus times were determined from the "Field Method". TABLE C5 is for the existing bus network "E", TABLE C6 for proposed network "P" and TABLE C7 for proposed network "EP". These tables have not been divided into ranges of house sale value, as were TABLES C1 to C4. They are divided by destination zone only.

TABLES C1 to C4 do not list population density while TABLES C5 to C7 do not list bus excess time, because bus excess time was assumed constant for all zones north of 127th Avenue. The reason for this was that all bus stops in each of these zones had been considered in the population of bus stops from which the sample was selected for the interview survey.

To aid in sorting and tabulating the results, the programs were arranged and numbered as shown in TABLE D1.

The analysis of the results from the programs is discussed in CHAPTER V, under the heading "Mode Split Relationships".

RELATIONSHIP BETWEEN POPULATION DENSITY AND BUS ROUTE LOCATION

From the data collected for the location and distribution of the population, for the area north of 127th Avenue, it was possible to find the approximate population of each traffic zone (TABLE IV-1) and the approximate number of people within a given walking distance to the bus stop (TABLE IV-1), for the three bus route systems. They were the existing bus route (E), the proposed bus route (P), and the proposed bus route (EP). These calculations enabled a ratio to be determined of the people within walking distance of the bus stop to the total population of each traffic zone.

This ratio could be interpreted as a measure of efficiency of that bus route to attract passengers. A ratio of 1.0 means that all people within that traffic zone were within walking distance of the bus stop.

Another measure of efficiency could be obtained from a comparison between the sum of the miles covered for each bus route and the population ratio previously calculated. If two bus route systems have equal population ratios, but one system covers less miles than the other, then that system would be the more economical and hence the more efficient.

TABLE III-2 represents these factors for each of the three bus route systems.

TABLE III-2

POPULATION RATIO AND ROUTE STREET MILES FOR

EACH BUS ROUTE SYSTEM IN EACH TRAFFIC ZONE.

Zone	Population Ratio for Bus Route System.			Route Street Miles for each Bus Route System.		
	E	P	EP	E	P	EP
	Existing	Proposed	Combination of E and P	Miles	Miles	Miles
1310	0.86	0.83	0.86	5.36	6.48	5.36
1320	0.82	0.67	0.96	4.82	1.20	6.02
1330	0.73	0.50	0.95	2.40	1.20	3.60
1340	0.72	0.45	0.98	3.24	1.40	4.64
1410	0.85	0.51	0.89	6.00	3.36	9.36
1421	0.84	0.58	0.84	4.40	4.40	8.40
1431	0.89	0.47	0.93	4.66	3.00	7.60
1440	0.86	0.68	0.86	1.54	1.00	1.54
1920	1.00	0.73	1.00	2.30	1.90	2.30
1930	1.00	0.89	1.00	2.38	1.62	2.38
			TOTAL	36.6	25.2	51.2

A similar table (TABLE III-3) can be presented for all the zones combined.

TABLE III-3

POPULATION RATIO AND ROUTE STREET MILES FOR EACH BUS

ROUTE WHEN THE TRAFFIC ZONES HAVE BEEN COMBINED.

Bus Route System	Population Ratio	Route Street Miles	$\frac{\text{Population Ratio}}{\text{Route Street Miles}}$ R x 10^{-2}
Existing "E"	0.84	36.6	2.3
Proposed "P"	0.60	25.2	2.4
Proposed "EP"	0.92	51.2	1.8

The ratio of "Population Ratio" to "Route Street Miles" shown in the last column of TABLE III-3 can be used for comparison between the different bus route systems.

$$R = \frac{\text{Population within walking distance}}{\text{Total Population} \times \text{Route Street Miles}}$$

For a constant total population, R can be used as a measure of efficiency but not as a measure of service. TABLE III-3 illustrates that although the R factor for the existing bus route "E" and proposed bus route "P" are almost the same the population ratios are 0.84 and 0.60 respectively. To achieve a population ratio of 1.0 and maintain a level of efficiency equal to 2.4×10^{-2} would mean that the route street miles must be increased to 41.7 miles, which depending on the physical constraints of the area may or may not be possible. Therefore although proposed bus route "EP" has a higher population ratio than either of the other bus routes it has a lower "R" value and is thus less efficient.

CHAPTER IV

DATA COLLECTION

The data collected for this thesis will be discussed under the following headings.

Traffic Zones.	Population Density.
Bus Travel Times.	Bus Route Location.
Car Travel Times.	House Sale Values.
Excess Bus Travel Times.	Mode Split.
Excess Car Travel Times.	

TRAFFIC ZONES

The traffic zones used in this thesis differ slightly from those presented in either Rhyason's or Halls' theses. Firstly the number of traffic zones has been increased from 141 to 212 and secondly, some zones, such as 1430, have been subdivided into smaller zones (1421 and 1431).

Traffic zones are designed to show areas of the city which have similar land use characteristics and similar economic status. These two factors are important in Transportation Engineering as they are two of the biggest factors determining trip generation from an area.

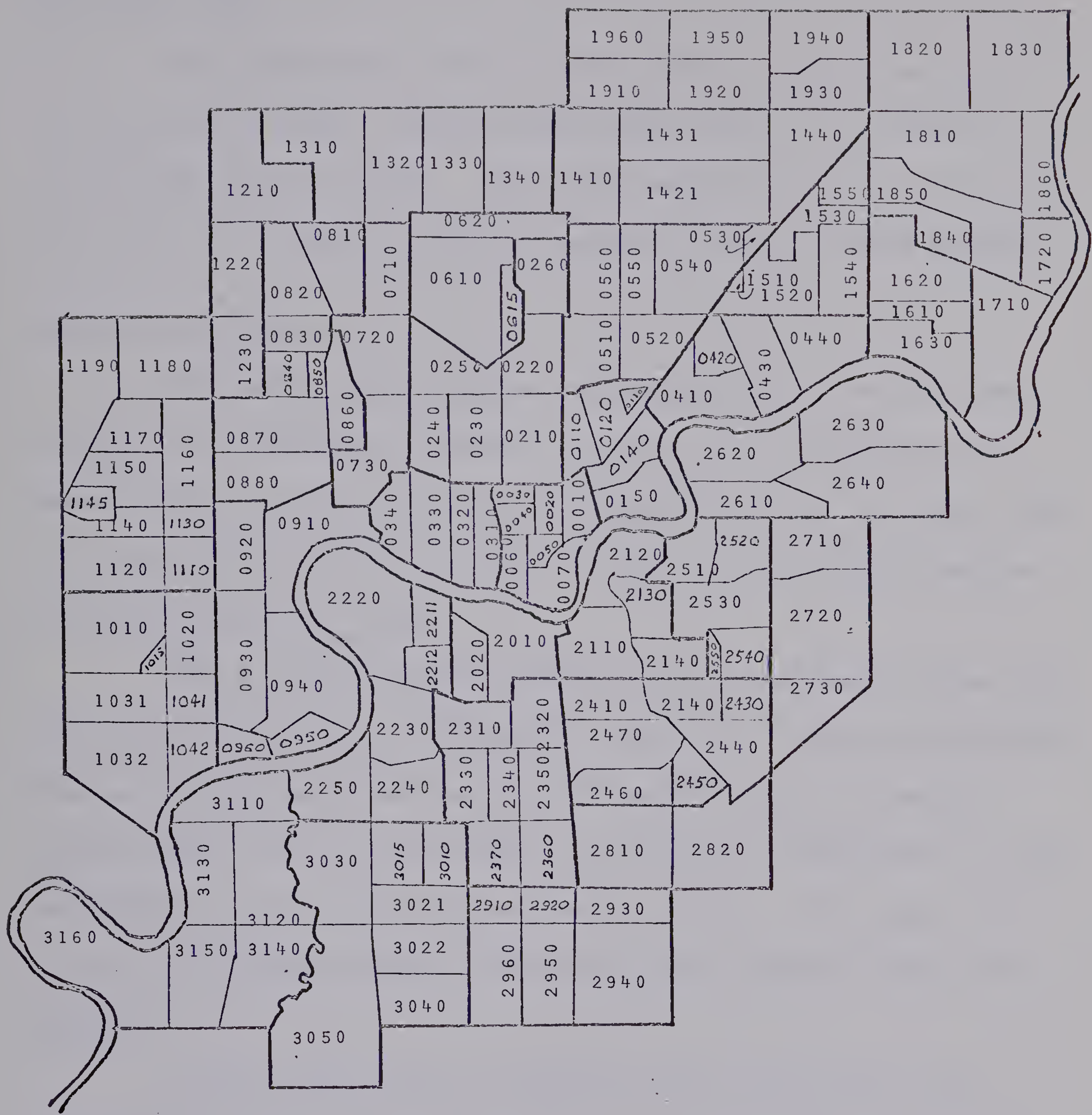
The original zones were drawn up at the time of the M.E.T.S. study, since when land use patterns have changed in some sections of the city and the size of the city has increased. This has necessitated changing some existing traffic zones and adding new ones.

The traffic zones used in this thesis were prepared by the

City of Edmonton Engineering Department; Traffic Branch.

For the C.B.D. destination zones, both Rhyason and Halls combined various traffic zones and represented them by a single zone centroid. They used centroid "1" for zones "0010 + 0020", centroid "2" for zones "0030 + 0040" and centroid "4" for zone "0060". The traffic zones have not been combined for this thesis as it was found more expedient to use the zones as they presently exist. The reason is that all the C.B.D. bus stops used were located in zones "0010", "0020", "0040" and "0060". The zone centroid for these zones are "1", "2", "4" and "6" respectively. See FIGURE 5 for the traffic zones and zone centroids used in this thesis.

Rhyason's and Halls' C.B.D. destination zone centroids "2" and "4" have the same location as the zone centroids for zones "0040" and "0060" respectively. Halls' bus travel times to these zone centroids have therefore not been adjusted, while the times to zone centroid "1", representing the combined zone of "0010 + 0020" have been adjusted, to allow for the times to the separate zones of "0010" and "0020" to be calculated.



TRAFFIC ZONES

FIGURE 5

BUS TRAVEL TIMES

Two methods were used to calculated bus travel times, the first method used Halls' Minimum Path program and will be referred to as the "Minimum Path Method". The second method used times calculated from riding time checks and will be referred to as the "Field Method".

Minimum Path Method.

Bus travel times were not calculated from all traffic zones, as time was not available, however, bus times were calculated for 35 zones on the north side of the North Saskatchewan River. Data from 1964 were used as the bus schedule times for 1964 and 1967 showed that bus times had remained the same.

The bus travel times included travel time, transfer time, and time for walking to final destination, they did not include walking from home to the bus stop or waiting time at the bus stop. To find the actual travel time, the excess time factors had to be subtracted. Halls used the excess times that were derived by Rhyason. The origin zones used were the same zones Halls used except their centroid numbers were changed.

As discussed under the heading "Traffic Zones" the zone centroid "1", that Halls used referred to the combined zones "0010 + 0020". These zones are not combined in this thesis, so adjustments were required to find the difference in travel times from this zone centroid to the destination zone centroids "1" and "2" that are used here.

The method used to calculate this difference was to first find the actual travel time and route taken from the origin zone to Halls

destination zone centroid "1", and then adjust this time to give the travel times to the bus stop closest to either of the two zone centroids for zones "0010" and "0020". The destination walking time was then found by finding the time to walk from this bus stop to the zone centroid at an approximate speed of 3.33 miles per hour. This average walking speed was determined by Rhyason. APPENDIX A gives a detailed example of the method used, see TABLES A1 to A4 and the explanation for these tables found immediately after TABLE A4.

Field Method

This method was only used for those traffic zones north of 127th Avenue.

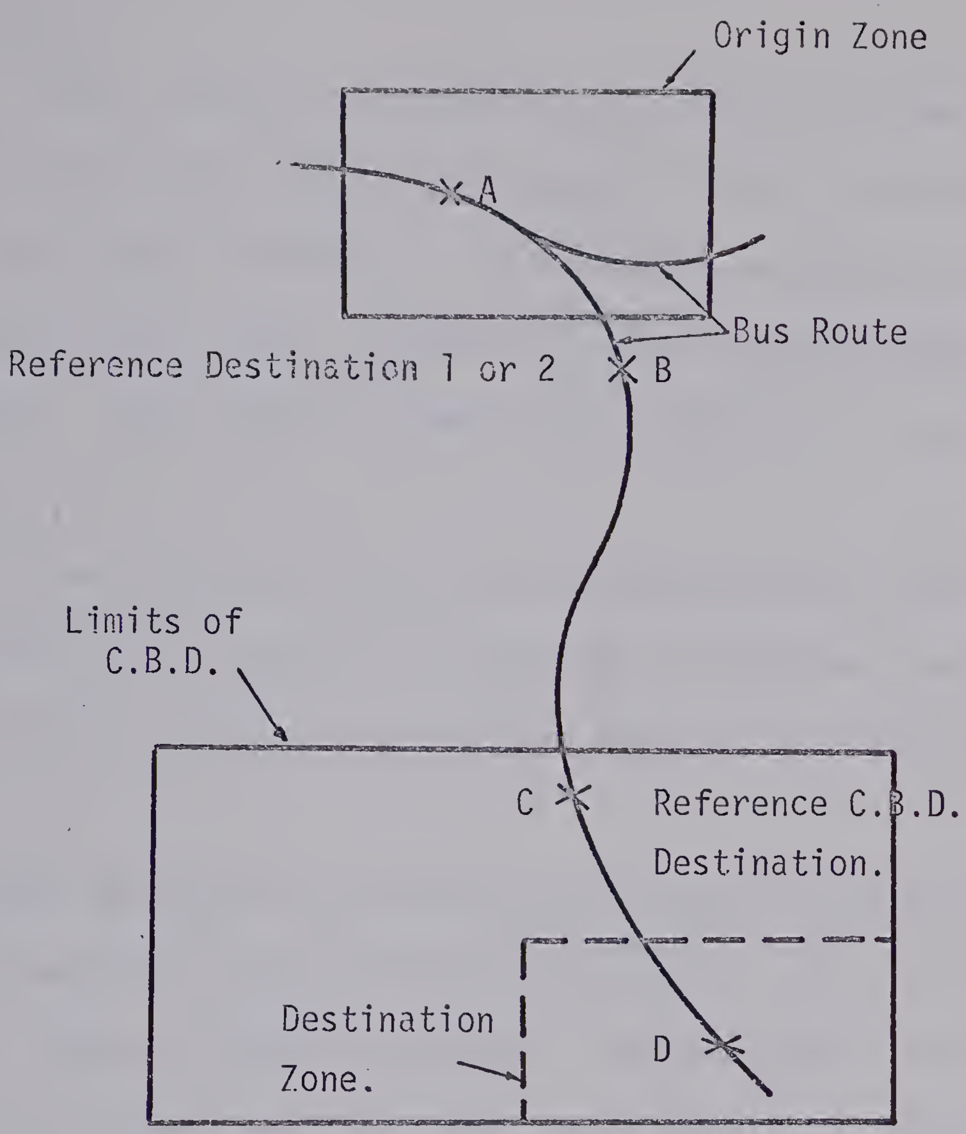
The travel times from origin zones to destination zones was obtained by measuring the travel times from each bus stop in the origin zones to each bus stop in the destination zones and then finding the average of these times for a particular origin-destination zone combination.

TABLE A8 lists the location of the bus stops and the bus running time only to each of the C.B.D. destination zones. The travel time from each origin zone to each destination zone was then found by averaging the travel time from all bus stops in that zone (TABLE A9).

To calculate the travel times for the proposed bus route "P", a different procedure was adopted. The average speed for each existing bus route "E" was calculated (TABLE A12), the travel time from Reference Destination Number 2 to Reference C.B.D. Destination (TABLE A13), the time adjustments from the Reference C.B.D. Destinations to each destination zone (TABLE A13) and the average time from the origin zone to

Reference Destination Number 2 (TABLE A14) were also calculated. The factors were combined to give the travel times between each origin zone and each destination zone (TABLE A15). FIGURE 6 illustrates pictorially the method used.

For proposed bus route "EP", the bus travel times for bus routes "E" and "P" were combined as shown in TABLE A16 and the explanations for this table.



A-B . . Average distance from origin zone to Reference Destination 1 or 2.

B-C . . Schedule bus time given for this distance.

C-D . . Distance for which time adjustment is applied, represents average distance of bus stop in destination zone, from "C".

DIAGRAMMATIC REPRESENTATION OF TERMS USED IN DESCRIBING BUS ROUTES.

FIGURE 6

CAR TRAVEL TIMES

In 1967, the City of Edmonton Engineering Department, Traffic Branch, produced a link network line diagram for the centroid and collector road system in Edmonton. Each link is represented by an origin and destination node, average auto speed and approximate time to travel the link. The times and speeds are determined for peak hour traffic only.

The map also has the zone centroids connected to the road network by dummy links, hence it is possible to find the time between any two zones using the zone centroids as the starting and finishing points.

Using the same 35 zones that were used for finding bus travel times, car travel times were determined from those zones tc destination zones "0010", "0020", "0040" amd "0060". The times, distances and route taken to each of these zones were calculated using Halls' minimum time program.

Car travel times for each origin-destination zone combination is given in TABLE B1.

EXCESS BUS TRAVEL TIMES

Excess bus travel times include the time to walk from home to the bus stop, time spent waiting for the bus, transfer time and time taken to walk from the bus stop to the final destination.

As two methods were used for finding bus travel times, so two methods were also used for finding excess bus times.

For the area north of 127th Avenue an interview survey was made, which consisted of an interviewer standing at a bus stop and handing out questionnaire cards to people as they arrived for the bus. The person then answered the question immediately and returned the card to the interviewer. The bus stops were selected randomly, 23 of which were used in the survey. No special attention was given to particular bus stops or the number of people expected to be interviewed.

The survey was designed to collect such information as walking distance from home to the bus stop, waiting time for the bus and walking distance from the bus stop to work. TABLE A10 lists this information for each bus stop included in the survey.

The total number of people interviewed was 270 but only the data for those trips destined for the C.B.D. was used in the analysis, namely 155. One person refused to give his home and work address, however, from the method used to collect the information it was possible to determine the person's sex, waiting time at the bus stop, and bus route taken.

For walking distance to and from the bus stop and waiting time at the bus stop, a statistical analysis was made to find out how statistically significant were the results. The statistical analysis method used was "Cluster Sampling Technique for Unequal Sized Clusters" (STUART 1962). This analysis showed that there was a 99% (percent)

probability of the mean walking distance to the bus stop being 892.90 $\pm$ 93.77 feet, the mean waiting time being 3.88 $\pm$ 0.29 minutes and the mean walking distance from the bus stop to work of 606.66 $\pm$ 47.37 feet. Results of the statistical analysis are discussed in the next chapter under the heading "Bus Excess Times".

FIGURE 7 shows the layout of the questionnaire card that was used for the interview survey.

The other method of obtaining excess times was used for the 35 zones in which the bus travel times were found using Halls' Minimum Time program. This method used the excess time values calculated by Rhyason, except that the maximum allowable waiting time was set at 3.88 minutes, instead of 5.0 minutes. This value agrees with the average waiting time determined from the interview survey.

There was not enough time to do a complete interview survey for these 35 zones hence the main reason for using Rhyason's values. The excess times for the zones north of 127th Avenue could be determined from the interview survey. TABLE V-2, compares Rhyason's excess times with the excess times from the interview survey for each zone.

A list of Rhyason's excess times for the 35 zones under consideration are given in TABLES A1 to A4, APPENDIX A.

The distance walked to the bus stop was determined by measuring the distance on a 1" = 1400 feet scale map of Edmonton, from the home address to the bus stop. The walking distance from the bus stop to work was obtained the same way.

The greatest accuracy that could be obtained in measuring these distances from the map was about 120 feet or an actual scaled

BUS STOP LOCATION: | | Av. | | St.

TO BUS RIDERS: Please help to plan your future bus system by answering the following questions.

Home Address ....
(or nearest street corner)

....

Work Address ....
(or nearest street corner)

....

Sex: [M] [F]

DO YOU KNOW APPROXIMATELY WHAT TIME THE BUS WILL ARRIVE AT THIS BUS STOP? [YES] [NO]

WHAT BUS ARE YOU WAITING FOR? [ ] [ ] [ ] [ ]

Thank you for your co-operation. Please return card to interviewer

TIME (A.M.)			
Hour			
6	7	8	
Minutes			
1	16	31	46
2	17	32	47
3	18	33	48
4	19	34	49
5	20	35	50
6	21	36	51
7	22	37	52
8	23	38	53
9	24	39	54
10	25	40	55
11	26	41	56
12	27	42	57
13	28	43	58
14	29	44	59
15	30	45	60

QUESTIONNAIRE CARD USED IN INTERVIEW SURVEY

FIGURE 7

distance of 0.05". This represents approximately a quarter of the length of a standard city block.

Waiting time was found by marking on the card the time the person arrived at the bus stop, and then comparing this time with the actual arrival time of the bus. The arrival time of the bus was noted by marking a card with the arrival time, route number and a large letter "B" written across the face of the card.

EXCESS CAR TRAVEL TIMES

Excess travel time by car includes the time for unparking at the origin and looking for a parking space and parking at the destination end, and walking from the parking location to the final destination.

Neither Rhyason or Halls allowed any time for unparking at the origin or finding a parking space. Most workers park in the same location each day, hence the time spent looking for a parking space would be negligible. Rhyason quotes four minutes as the time spent in parking the car and walking to the final destination. This same time will be used in this thesis.

POPULATION DENSITY

At the beginning of 1969, as part of an assignment in Geography 508, a land use survey was made of all the multi-family dwelling units in the area north of 127th Avenue. Using a car, and driving around all the streets in the area, the number of multi-family dwelling units in each block were determined by counting the number of mail boxes associated with each building. The number of units counted for each structural type were,

Basement Suites	=	384
Converted Dwellings	=	9
Duplexes	=	1,057
Row Houses	=	1,955
Walk-ups	=	943
TOTAL	=	4,348

The density for all the multi-family units were then plotted on a grid square map, where the grid size was 200 x 200 meters (FIGURE E1).

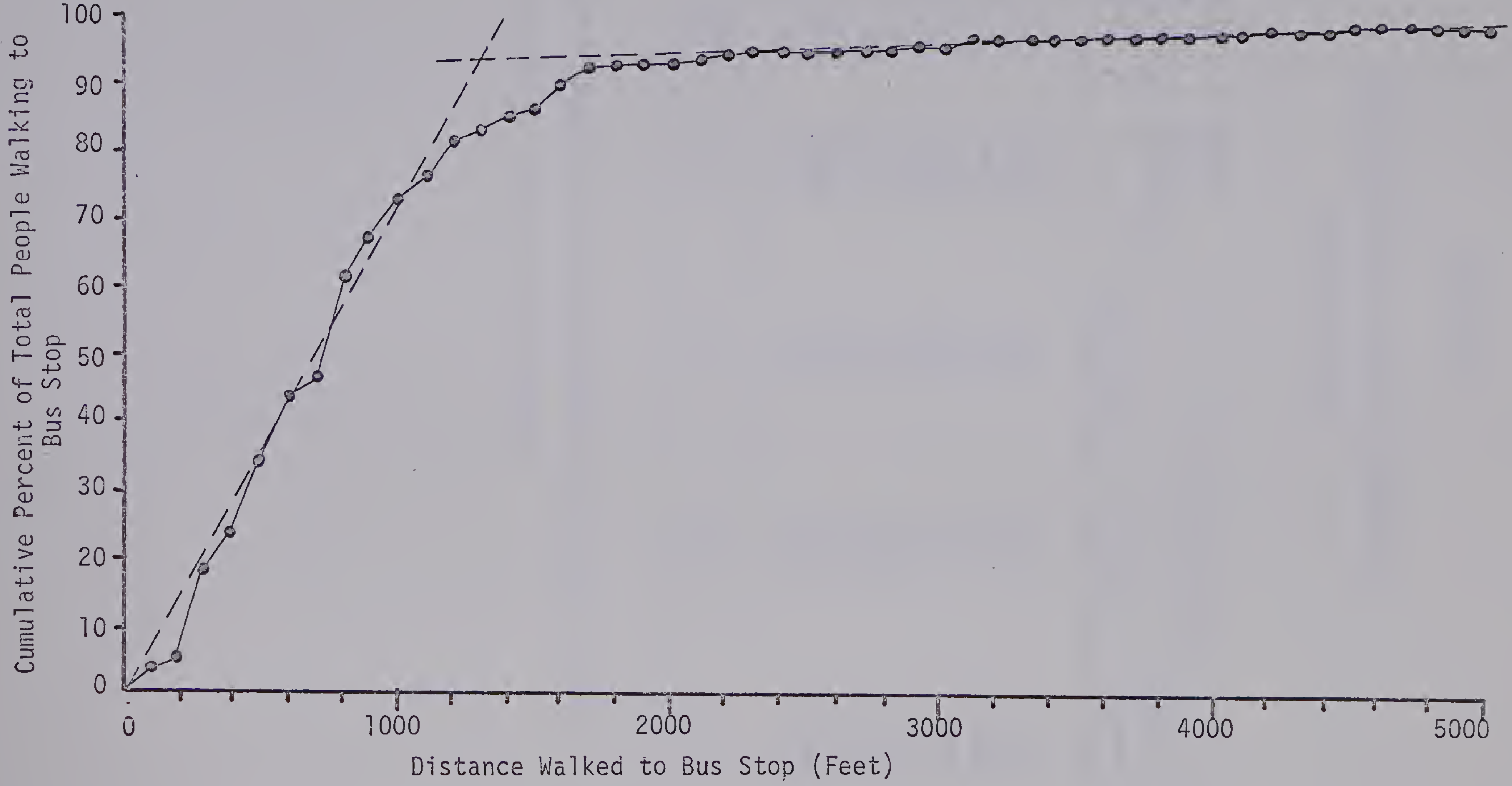
Single family dwelling units were not counted but their location was noted. Using air photos, grid squares were selected randomly and the number of single-family dwelling units in each grid square tabulated, so that their average density per grid square could be determined. This was about 40 units per grid square or seven units per net acre.

From knowing the density of the multi-family dwelling units, the approximate density and location of the single family dwellings and the average number of people per dwelling unit for each traffic zone,

it was possible to find the population within walking distance to any particular bus stop.

TABLE IV-1 is a summary of the total population, and the average number of people per dwelling unit, for each traffic zone. The average number of people per dwelling unit was determined from the "1968 Fall Civic Census". Included in TABLE IV-1 is the population within two average city blocks from bus routes, E, P and EP.

FIGURE 8 is a graph of "Distance Walked to the Bus Stop" versus "Cumulative Percent of Total People Who Walked to the Bus Stop". The break in this graph illustrates that approximately 94 percent of the people taking the bus walk less than approximately 1300 feet to the bus stop. As most people do not walk in a straight line from their home to the bus stop and the average spacing of bus stops is two city blocks, nearly all these people would live within 2 (two) average city blocks (or approximately 1000 feet) from the bus <u>route</u>. If compared with the standard spacing of bus routes aimed at by Transit Authorities, their aim is to have the bus routes spaced within a quarter (¼) mile (1320 feet), of any dwellings in the area. This is a straight line distance and does not take into account walking distance.



DISTANCE PEOPLE WALK TO THE BUS STOP. FIGURE 8

TABLE IV-1

POPULATION WITHIN WALKING DISTANCE TO

THE BUS ROUTES

Traffic Zone	People per Dwelling Unit	Total Zone Population	Pop. within Walking Distance of 1000 ft. to Bus Route		
			Existing Bus Route(E)	Proposed Bus Route(P)	Existing and Proposed B.R. Combined (EP)
1310	4.25	8686	7523	7183	7523
1320	3.26	6027	4890	4010	5738
1330	3.78	5947	4234	2457	5594
1340	3.82	7192	5157	3247	6991
1410	3.96	4580	3920	2416	4079
1421	4.20	8991	7518	5166	7518
1431	4.20	8422	7518	3948	7854
1440	4.50	5131	4410	3510	4410
1920	4.27	2347	2349	1708	2349
1930	4.20	4131	4116	3654	4116
TOTAL	Average 4.01	61,454	51,635	37,299	56,172

See APPENDIX E for maps showing relationship between population densities and bus route location.

BUS ROUTE LOCATION

In order to understand some of the factors which affect bus route location, three different bus route locations have been selected in North Edmonton, north of 127th Avenue.

These three bus routes consist of the existing bus route system (designated "E"), a proposed bus route system (designated "P") and a combination of the existing and proposed bus route system (designated "EP").

The location of the proposed bus route "P", centered on 132nd Avenue, is an obvious choice for a bus route. 132nd Avenue is a main arterial street running from the eastern to the western boundary of the area and passing through or within walking distance to sectors having the highest residential density in the area.

Bus stops are spaced at an average of two city blocks, for the existing and proposed bus routes. Since the length of the average city block in Edmonton is 500 feet, the approximate spacing of bus stops is 1,000 feet.

A comparison of the three (3) bus route systems in "route street miles" (street miles for each bus route in the area) and population density within walking distance to the bus routes is shown in TABLE III-2 and discussed in the next chapter. FIGURE E1 illustrates the location of each bus route.

HOUSE SALE VALUE

The average house sale value of an area was found by Rhyason to be highly correlated with the average level of income for that area. Level of income or economic status of an area was found by Rhyason to affect the number of bus riders originating from that area.

Rhyason found that for Edmonton, the higher the level of income for an area, above a certain level, the lower was the mode split expected from that area.

TABLE IV-2 gives a list of the house sale values for each zone from which bus and car times were calculated.

TABLE IV-2

AVERAGE 1967 HOUSE SALE VALUES

Zone	Average House Sale Value $	Zone	Average House Sale Value $	Zone	Average House Sale Value $
0210	15,489	0710	10,807	1330	13,610
0220	13,643	0720	12,932	1340	14,810
0230	14,917	0730	13,191	1410	16,898
0240	15,489	0810	15,055	1421	16,901
0250	15,100	0820	14,862	1431	16,898
0260	12,830	0830	17,922	1440	15,274
0340	15,617	0860	14,044	1520	11,710
0430	12,938	0870	17,490	1620	13,025
0440	16,110	0880	14,174	1630	13,860
0510	11,204	1150	13,484	1920	-
0520	10,388	1160	11,354	1930	15,516
0540	11,714	1170	13,306	1940	15,516
0550	12,005	1310	13,325		
0560	11,517	1320	14,914		

MODE SPLIT

In 1967 the City of Edmonton Engineering Department, Traffic Branch, made an origin-destination survey. The results from this survey enabled the mode split for each origin zone to each destination zone in the C.B.D. to be calculated. TABLE IV-3 lists the mode split for those zones from which bus and car times were calculated. The destination zones were "0010", "0020", "0040" and "0060".

TABLE IV-3

MODE SPLIT FROM ORIGIN ZONES TO C.B.D. DESTINATION ZONES.

Origin Zone	Mode Split	Origin Zone	Mode Split	Origin Zone	Mode Split	Origin Zone	Mode Split
		DESTINATION	ZONE	- -	0010		
0210	37	0520	55	0860	45	1410	32
0220	53	0540	33	0870	26	1421	34
0230	57	0550	45	0880	30	1431	41
0240	48	0560	47	1150	34	1440	44
0250	40	0710	54	1160	41	1520	25
0260	50	0720	57	1170	36	1620	36
0340	48	0730	52	1310	41	1630	55
0430	45	0810	28	1320	35	1920	26
0440	47	0820	33	1330	35	1930	11
0510	60	0830	27	1340	39	1940	22
		DESTINATION	ZONE	- -	0020		
0210	44	0520	60	0860	42	1410	44
0220	44	0540	46	0870	25	1421	37
0230	48	0550	66	0880	34	1431	50
0240	46	0560	47	1150	26	1440	51
0250	23	0710	43	1160	52	1520	30
0260	63	0720	58	1170	31	1620	43
0340	40	0730	50	1310	48	1630	52
0430	53	0810	34	1320	54	1920	22
0440	48	0820	29	1330	40	1930	18
0510	71	0830	39	1340	36	1940	20

TABLE IV-3 (cont')

MODE SPLIT FROM ORIGIN ZONES TO C.B.D.

DESTINATION ZONES.

Origin Zone	Mode Split	Origin Zone	Mode Split	Origin Zone	Mode Split	Origin Zone	Mode Split
		DESTINATION	ZONE	- -	0040		
0210	19	0520	48	0860	32	1410	17
0220	20	0540	41	0870	15	1421	39
0230	30	0550	72	0880	25	1431	18
0240	14	0560	37	1150	30	1440	27
0250	14	0710	38	1160	37	1520	12
0260	17	0720	49	1170	16	1620	28
0340	52	0730	42	1310	20	1630	39
0430	47	0810	20	1320	32	1920	-
0440	44	0820	25	1330	39	1930	23
0510	55	0830	13	1340	22	1940	12
		DESTINATION	ZONE	- -	0060		
0210	20	0520	37	0860	15	1410	6
0220	18	0540	41	0870	5	1421	24
0230	25	0550	12	0880	21	1431	29
0240	25	0560	21	1150	18	1440	25
0250	20	0710	47	1160	27	1520	8
0260	34	0720	45	1170	16	1620	21
0340	34	0730	38	1310	24	1630	23
0430	30	0810	16	1320	45	1920	3
0440	31	0820	19	1330	21	1930	0
0510	40	0830	15	1340	28	1940	16

CHAPTER V

RESULTS AND ANALYSIS

BUS TRAVEL TIMES

Bus travel times were calculated using two methods. The "Minimum Path Method", using Halls' minimum time program gave lower bus travel times than did "The Field Method", which calculated travel times from riding time checks.

Halls did not consider every bus route north of 127th Avenue, he attempted to simplify the network by choosing only those bus routes which proceeded directly to the C.B.D. from the bus stop closest to the zone centroid. He therefore only considered the bus routes which would produce the minimum travel time from each zone. Even if the other bus routes had been included the travel times from each zone would probably still have been the same, because the minimum path route would have followed the route he selected.

This brings out a fallacy of using minimum time programs for complicated bus networks, as the minimum time calculated may not be truly representative of the average travel time for the traffic zone under investigation. Maybe this could be overcome by locating the zone centroid at the center of gravity at the bus stops, taking into account the approximate demand at each bus stop. Halls used the zone centroids which had been located for the road network. They had been located by taking the center of gravity of the population in the traffic zone. This method of locating zone centroids had been recommended by the U.S. Department of Commerce 1964, who had defined it as the point from which all trips

originate or to which all trips are destined.

Another factor which would affect the location of zone centroids for bus networks is that the trips originating in a zone and which will use the bus are not uniformly spread over the traffic zone, but vary inversely as the distance from the bus stop increases as shown in FIGURE 8. This graph shows that 43 percent of the people using the bus are within 500 feet walking distance, 81 percent within 1,000 feet, 90 percent within 1,500 feet and 94 percent within 2,000 feet.

The bus times derived from the riding time checks were an attempt to find average travel times from each traffic zone without resorting to the use of zone centroids. This method first found the travel time from each bus stop, at which the bus stopped to pick up passengers, and then found the average of the bus travel times for those bus stops in a particular traffic zone. This method gave equal weight to every bus stop, with no allowance being made for the number of people at each bus stop, and therefore may exaggerate the bus travel times from each zone. However if the number of people standing at each bus stop had to be taken into account, the bus travel times would have to be adjusted as the number of people at the bus stop varied, assuming that a different weight was given to the bus travel times from each bus stop.

CAR TRAVEL TIMES

The car travel times were calculated using Halls' minimum time program and a network map prepared by the City of Edmonton Engineering Department, Traffic Branch. This map was prepared in 1967, Rhyason and Halls used a similar network map, based on 1961 car travel times. TABLE V-1, which compares the travel times for 35 traffic zones north of the North Saskatchewan River, shows that the 1967 car travel times are generally lower than the 1961 car travel times, however as different procedures were used in preparing each map and many changes have been made to the street network since 1961, this comparison has little value, except as a rough guide to the accuracy of the results.

The main difference in procedure used for preparing each map, was that the travel times for 1961 were the average of more timed trips than were used in 1967. On some links in the 1967 map only one timed trip was used, which meant that if it was taken at some time when there was little delay at traffic lights, then biased results would be obtained.

The changes to the street network that have taken place since 1961 are the adoption of one-way streets in the C.B.D., the widening of various arterial streets leading into the city such as Kingsway Avenue, shorter cycle times for traffic lights, and the use of parking bans on streets during the peak hour to increase their capacity and to allow for a smoother flow of traffic.

The zone centroid method was used for finding the average time from each traffic zone. As mentioned in the previous section, this method is probably satisfactory because the probability of car trips being generated would be the same for any part of the traffic zone in which residences are located.

TABLE V-1

COMPARISON BETWEEN RHYASON'S CAR TRAVEL TIMES (1961)

AND THE CAR TRAVEL TIMES CALCULATED HERE (1967).

Origin Zone	Dest. Zone 0010+0020 & 0040		Dest. Zone 0060		Origin Zone	Dest. Zone 0010+0020 & 0040		Dest. Zone 0060	
	1961	1967	1961	1967		1961	1967	1961	1967
0210	7.7	7.3	10.1	9.7	0860	15.8	10.7	14.9	12.8
0220	12.2	9.3	13.7	11.7	0870	17.4	11.9	15.4	14.0
0230	9.3	7.3	11.0	9.7	0880	17.4	11.7	15.4	13.8
0240	11.3	8.0	12.1	10.0	1150	21.3	15.7	19.3	17.8
0250	13.1	9.6	14.0	11.7	1160	18.8	13.7	16.8	15.8
0260	15.7	12.6	17.3	15.0	1170	21.2	15.6	19.4	17.7
0340	13.1	8.2	12.7	9.1	1310	20.6	19.5	22.3	21.6
0430	17.2	14.8	18.4	17.2	1320	20.3	18.8	22.0	20.9
0440	19.2	15.4	20.3	17.8	1330	20.8	19.7	22.1	22.1
0510	14.3	11.1	15.7	13.5	1340	19.4	17.4	20.8	20.4
0520	14.5	12.9	15.9	15.3	1410	18.9	17.3	20.2	19.7
0540	18.6	16.4	19.3	18.8	1421	-	18.1	-	20.5
0550	18.2	15.5	19.5	17.9	1431	-	19.5	-	21.9
0560	16.1	13.3	17.4	15.7	1440	22.5	21.1	23.9	23.5
0710	16.1	12.1	17.8	14.2	1520	19.8	18.0	21.0	20.4
0720	15.4	10.6	16.2	12.7	1620	24.1	19.1	25.1	21.5
0730	12.3	8.9	12.9	11.0	1630	23.2	18.3	24.0	20.7
0810	17.8	14.3	17.6	16.4	1920	-	21.3	-	23.7
0820	18.3	14.8	18.1	16.9	1930	-	22.6	-	25.0
0830	17.6	13.0	16.8	15.1	1940	-	23.4	-	25.8

BUS EXCESS TIMES

For the zones where the bus travel times were calculated using Halls' Minimum Time Program, the excess times were derived by Rhyason (except waiting time). Rhyason used the zone centroid method for calculating walking time to and from the bus stop, that is, he determined the distance from the zone centroid to the closest bus stop and the average walking speed and then calculated the actual walking time. This method was used at both the origin and destination end of the trip. Waiting time was calculated by taking half the schedule time to a maximum of five minutes, which was reduced to 3.88 minutes for this thesis, to agree with the results of the interview survey.

For the zones north of 127th Avenue where travel times had also been calculated using the Field Method, the excess times were derived from an interview survey of a sample of people catching the bus. For a further discussion on the method used see the section on Bus Excess Times in the chapter on Data Collection. The end result of this survey was that walking distance to the bus stop, waiting time at the bus stop and walking distance from the bus stop to work could be statistically determined. The data for the interview survey was collected during April, 1969. A program (APPENDIX F) was written to analyse this data, and the results from it are listed in TABLES V-4, V-5, V-6.

These tables give, for each factor being investigated, the total number of people interviewed, the mean, the variance and the standard error. The probabilities of getting different percent errors are listed, for example the analysis of walking distance from home to the bus stop, the probability the mean will have a maximum error of 4.19 percent is 70 percent, while the probability it will have a maximum

error of 10.50 percent is 99 percent.

To calculate the excess time from the results of the interview survey, the same average walking speed was used as was calculated by Rhyason, that is 3.33 miles per hour. This resulted in the time to walk to the bus stop of 3.05 minutes and the time to walk from the bus stop of 2.07 minutes, adding the waiting time of 3.88 minutes gives a total excess time of 9.0 minutes. The transfer time was the average of the actual transfer time for those bus routes under investigation and operating between the hours of 7.00 AM and 9.00 AM.

The excess times calculated from the interview survey must be used for each of the traffic zones north of 127th Avenue as all these zones were considered when the sample was being selected.

For a comparison of the excess times calculated by each method, for the traffic zones north of 127th Avenue, see TABLES V-2, V-3.

In 1963 a C.B.D. pedestrian survey (10 percent sample of adults) was made to determine, among other things, the distance people walked from the bus stop to work (Hill, Bakker and Akers, 1964). TABLE V-3 summarizes the data collected from this survey for those people interviewed between 7.30 AM and 9.00 AM. The specific locations at which the survey was conducted in the C.B.D. have also been listed.

The overall average walking distance calculated from this survey was approximately 550 feet, this is only approximate because the original data tabulated walking distance in blocks and this distance was converted to feet by multiplying by the average length of a city block which is 500 feet. The mean walking distance, as calculated from this interview survey for this thesis (TABLE V-5) was 606.66 feet (difference of approximately one lot).

The mean waiting time calculated in TABLE V-6 is interesting in that the minimum bus schedule time for this area is 20 minutes, therefore there appears to be no relationship between the bus schedule time and the mean waiting time. This may only be so for the peak morning trips as 98 percent (TABLE A-17) of all people interviewed said they knew the bus schedule. For trips other than work trips made during the day there may be less likelihood that the bus schedule is known, hence waiting time may increase. This could be prevented, however by allowing people to have easy access to bus schedules.

TABLE V-2

COMPARISON OF BUS RUNNING TIMES CALCULATED FROM THE MINIMUM PATH METHOD AND THE FIELD METHOD

Origin Zone	Destination Zone "0010"				Destination Zone "0020"			
	Minimum Path Method		Field Method		Minimum Path Method		Field Method	
	Bus (a) Running Time	Excess Time	Bus (a) Running Time	Excess Time	Bus (a) Running Time	Excess Time	Bus (a) Running Time	Excess Time
1310	18.1	10.9	30.4	9.0	18.1	10.2	32.3	9.0
1320	20.0	10.4	33.4	9.0	20.0	9.7	37.0	9.0
1330	26.2	9.7	31.7	9.0	26.2	9.0	38.7	9.0
1340	22.7	11.5	29.8	9.0	22.7	10.8	36.8	9.0
1410	18.3	12.0	31.7	9.0	18.3	11.3	38.8	9.0
1421	(b)	(b)	32.0	9.0	(b)	(b)	36.9	9.0
1431	(b)	(b)	34.2	9.0	(b)	(b)	38.8	9.0
1440	27.6	10.5	19.6	9.0	27.6	9.8	22.1	9.0
1920	(b)	(b)	43.6	9.0	(b)	(b)	46.1	9.0
1930	(b)	(b)	34.2	9.0	(b)	(b)	36.7	9.0

(a) Includes Tranfer time.

(b) No 1967 figures available.

TABLE V-2 (cont')

COMPARISON OF BUS RUNNING TIMES CALCULATED FROM THE MINIMUM PATH METHOD AND THE FIELD METHOD

Origin Zone	Destination Zone "0040"				Destination Zone "0060"			
	Minimum Path Method		Field Method		Minimum Path Method		Field Method	
	Bus (a) Running Time	Excess Time	Bus (a) Running Time	Excess Time	Bus (a) Running Time	Excess Time	Bus (a) Running Time	Excess Time
1310	15.6	11.0	39.7	9.0	20.4	9.0	44.2	9.0
1320	17.5	10.5	42.9	9.0	22.3	8.5	47.2	9.0
1330	33.7	9.8	41.7	9.0	43.0	7.8	45.6	9.0
1340	29.6	11.6	39.8	9.0	39.4	9.6	43.7	9.0
1410	25.2	12.1	41.7	9.0	35.0	10.1	45.6	9.0
1421	(b)	(b)	39.3	9.0	(b)	(b)	42.9	9.0
1431	(b)	(b)	41.0	9.0	(b)	(b)	44.6	9.0
1440	23.4	11.6	23.7	9.0	19.2	8.6	27.0	9.0
1920	(b)	(b)	47.7	9.0	(b)	(b)	51.0	9.0
1930	(b)	(b)	38.3	9.0	(b)	(b)	41.6	9.0

(a) Includes tranfer time.

(b) No 1967 figures available.

TABLE V-3

1963 C.B.D. PEDESTRIAN SURVEY RESULTS[a]
(between 7.30 AM and 9.00 AM).

Buildings Used for Survey	Nos. of People Interviewed N	Total Number of Blocks Walked P	Average P/N
McLeod	13	(14 blocks) 7,000 ft.	533.46
Provincial Adm. Bldgs.	17	(7 blocks) 3,500 ft.	205.88
Hudson's Bay	0	0	0
City Hall	25	(46 blocks) 23,000 ft.	920
Federal Buildings	34	(31 blocks) 15,500 ft.	455.9
Overall Average			550.56

(a) Hill, Bakker and Akers, 1964).

TABLE V-4

ANALYSIS OF WALKING DISTANCE FROM HOME TO BUS STOP FOR DATA COLLECTED FROM INTERVIEWING PEOPLE WAITING AT BUS STOPS

Total number of people interviewed = 220

Mean walking distance to bus stop = 892.90

Variance of the complete sample = 286160.

Standard error of complete sample = 36.07

Probability (%)	Absolute Error (feet)	Percent Error (%)
70	37.42	4.19
75	41.53	4.65
80	46.89	5.25
85	52.22	5.85
90	59.40	6.65
95	70.69	7.92
99	93.77	10.50

TABLE V-5

ANALYSIS OF WALKING DISTANCE FROM BUS STOP TO WORK FOR DATA COLLECTED FROM INTERVIEWING PEOPLE WAITING AT BUS STOPS

Total number of people interviewed	=	155
Mean walking distance from bus stop	=	606.66
Variance of the complete sample	=	51405.58
Standard error of the complete sample	=	18.21

Probability (%)	Absolute Error (feet)	Percent Error (%)
70	18.90	3.11
75	20.97	3.46
80	23.67	3.90
85	26.37	4.35
90	29.99	4.94
95	35.69	5.88
99	47.35	7.80

TABLE V-6

ANALYSIS OF WAITING TIME AT BUS STOP FOR DATA COLLECTED FROM INTERVIEWING PEOPLE WAITING AT BUS STOPS

Total number of people interviewed	=	155
Mean waiting time	=	3.88
Variance of the complete sample	=	1.95
Standard error of complete sample	=	0.11

Probability (%)	Absolute Error (feet)	Percent Error (%)
70	0.12	3.00
75	0.13	3.33
80	0.15	3.76
85	0.16	4.19
90	0.18	4.76
95	0.22	5.67
99	0.29	7.52

MODE SPLIT RELATIONSHIPS

The aim of the theory presented in CHAPTER II was to present a method for testing the factors affecting the location of bus routes. The method first required that relationships be established between mode split and these factors, such as level of service and then the relationships applied to the new bus routes to see how the mode split would be affected.

The results of the mode split relationships for the zones whose bus times were calculated using the Minimum Path Method, are listed in TABLE V-7. It was intended to list as a comparison, the mode split relationships of the existing bus network "E" whose bus times had been determined using the "Field Method", however no statistically significant results were obtained from the regression analysis for this method.

From the graphs produced for bus network "E" from the regression analysis, it was noticed that if the factors for the origin zone 1930 to destination zones "0010" and "0020" were excluded from the regression analysis, for this origin-destination zone combination, the correlation coefficients would greatly increase. No one (1) zone was found to have a similar influence on the results for destination zones "0040" and "0060". Origin zone 1930 was typified by a very low mode split (11%) in comparison to the mode splits for the other zones in the area. TABLE V-7 therefore lists the mode split relationships for existing network "E" with the factors for zone 1930 excluded. The table only lists the results from zones whose "house sale value is over $13,000."

A more detailed analysis of zone 1930 was carried out to try

and determine why the mode split was so low, in comparison to the mode splits of other zones in the area.

Bus service to zone 1930 was introduced on December 14th, 1964, during the peak hours only. It was not until February, 1968, (3) months after the "Origin-Destination" home to work survey of 1967, that an all day service was started. The peak hour service could have discouraged people using the bus because of the restriction placed on them for the time they started and finished work, and in particular the restriction placed on them, for the time they must return home from work if they are to use the bus.

TABLE V-8 lists the annual population and the annual peak hour trips per day for each year since 1965. The table shows that although the population has more than doubled since 1966, the average trips per person per day (morning peak hours only) has progressively decreased.

The results from the field time checks (TABLE C5) revealed that neither travel time ratio, travel time difference, bus running time only or total bus travel time was a maximum value for zone 1930, when the destination zones were either "0010" or "0020".

From a study of the maximum and minimum travel times for each origin zone (TABLE V-9), however, it was found that the two zones with the lowest mode split, 1920 and 1930, had the highest, minimum, travel time only, and in each case it was over 30 minutes, excluding excess time.

The results in TABLE V-7 show that only three (3) factors are represented as having a level of significance of either 5 percent or 1 percent, in both the Minimum Path Method and the Field Method. These

factors are travel time difference, bus running time only and total bus travel time, and all occur in the results for destination zone "CC10".

The graphs for all results having statistically significant relationships at either 5% or 1% are shown in APPENDIX D. Where statistically significant results occur using both methods, the graphs for the other method are shown superimposed, that is, total bus travel time is statistically significant at the 1% level for both methods, therefore on each graph of mode split versus total bus travel time, the location of the regression line determined using, say the Minimum Path Method, is shown superimposed on the graph for the Field Method and vice-versa.

TABLE V-7

COMPARISON OF MODE SPLIT RELATIONSHIPS FROM

USING THE TWO METHODS OF CALCULATING BUS TIMES

Dest. Zone	Factor Under Investigation	Level of Significance: Minimum Path Method	Level of Significance: Field Method	Constants in the Linear Regression Equation Y = A + BX: Minimum Path Method A	Minimum Path Method B	Field Method (Existing Network "E") (adjusted) A	Field Method (Existing Network "E") (adjusted) B
0010	Travel Time Ratio		1	-	-	62.2130	-11.5306
	Travel Time Difference	5	1	53.9165	-0.925360	53.2318	- 0.752901
	Bus Running Time Only	5	1	51.6415	-0.621048	59.2908	- 0.721431
	Bus Excess Time	5		70.6555	-2.78600	-	-
	Total Bus Travel Time	1	1	60.2149	-0.680484	65.7807	- 0.721358
	Population Density Ratio			-	-	-	-
0020	Travel Time Ratio		5	-	-	60.9139	-10.1947
	Travel Time Difference		5	-	-	53.5468	- 0.650658
	Bus Running Time Only		1	-	-	61.7031	- 0.697186
	Bus Excess Time			-	-	-	-
	Total Bus Travel Time		1	-	-	67.9745	- 0.697113
	Population Density Ratio			-	-	-	-

TABLE V-7 (cont')

COMPARISON OF MODE SPLIT RELATIONSHIPS FROM

USING THE TWO METHODS OF CALCULATING BUS TIMES

Dest. Zone	Factor Under Investigation	Level of Significance: Minimum Path Method	Level of Significance: Field Method	Constants in the Linear Regression Equation Y = A + BX: Minimum Path Method A	Minimum Path Method B	Field Method (Existing Network "E") (adjusted) A	Field Method (Existing Network "E") (adjusted) B
0040	Travel Time Ratio	5		42.1430	-6.31572	-	-
	Travel Time Difference	5		41.3184	-0.801341	-	-
	Bus Running Time Only			-	-	-	-
	Bus Excess Time			-	-	-	-
	Total Bus Travel Time			-	-	-	-
	Population Density Ratio			-	-	-	-
0060	Travel Time Ratio	5		37.2134	-6.13000	-	-
	Travel Time Difference	1		36.7916	-0.675832	-	-
	Bus Running Time Only	5		34.5553	-0.505774	-	-
	Bus Excess Time	1		53.5128	-2.39325	-	-
	Total Bus Travel Time	1		42.7778	-0.547248	-	-
	Population Density Ratio			-	-	-	-

TABLE V-8

ANNUAL POPULATION AND ANNUAL PEAK HOUR

BUS TRIPS PER PERSON FOR ZONE 1930

Year	Population	Average trips per Day (6.00 AM to 9.00 AM)	Average peak hour trips per person per day
1965	Not Available	11.8	-
1966	1042	23.8	2.28×10^{-2}
1967	1558	29.0	1.86×10^{-2}
1968	2563	41.0	1.66×10^{-2}
1969	Not Available	43.2	-

TABLE V-9

MAXIMUM AND MINIMUM, BUS RUNNING TIME ONLY,[a] FOR

EACH ORIGIN ZONE TO DESTINATION ZONES "0010" AND "0020"

Origin	Destination Zone "0010"			Destination Zone "0020"		
Zone	Max.Time	Min.Time	Difference	Max.Time	Min.Time	Difference
1310	40.00	22.38	17.62	41.95	24.33	17.62
1320	40.83	24.00	16.83	42.88	25.95	16.93
1330	38.11	25.11	13.00	45.13	32.13	13.00
1340	41.52	22.27	19.25	48.54	29.29	19.25
1410	41.99	18.36	23.63	49.01	25.38	23.63
1421	43.27	20.74	22.53	50.29	23.24	27.05
1431	42.74	23.49	19.25	49.76	25.99	23.77
1440	23.77	16.08	7.69	26.27	18.58	7.69
1920	49.26	30.86	18.40	51.76	33.36	18.40
1930	36.74	31.91	4.83	39.24	34.41	4.83

(a) Includes transfer time.

BUS ROUTE LOCATION

From the mode split relationships discussed in the previous section it is now possible to apply them to the factors determined for the two proposed bus routes (see TABLES C6 and C7).

FIGURES D20 to D33 compare the mode split from each origin zone to each destination zone for the proposed bus routes and compare the mode split values obtained using the two methods of calculating bus times. For example FIGURE D21 is for destination zone "0010" and the factor used to calculate the mode split was "travel time ratio". The graph shows the curves for the two (2) proposed bus networks and the existing network. Beside the label for each curve is the method used to establish the "mode-split - travel time ratio relationship"; F.M. means Field Method, while M.P.M. means Minimum Path Method. "Proposed P (F.M.)" therefore means that the curve is for proposed bus network "P" and that the mode splits were calculated from the regression line whose bus times had been calculated using the "Field Method".

This procedure, however, does not take into account other important factors used in locating bus routes, for example, the actual distance people must walk to a bus stop, the distribution of population densities, the physical layout of the streets and the actual "route street miles" required to serve a particular area.

The mean walking distance to the bus stop of 892.90 feet had a 99 percent probability of having a maximum error of $\pm$ 93.77 feet. This meant that the average walking distance could be between 799.13 feet (1.6 blocks) and 986.67 feet (2.0 blocks). If 2.0 blocks was used as the average walking distance it would be convenient firstly because it is in

a whole multiple of blocks and secondly, the present average spacing of bus stops is 2.0 blocks. If bus routes could be located only taking into account walking distance, then their spacing would be four blocks or 2,000 feet, with bus stops every two blocks or 1,000 feet.

This method works well if the streets are layed out on the grid system, and the population density is uniform over the area. For the newer areas north of 127th Avenue, the grid system of streets has been phased out in preference to the neighbourhood system, which is partly responsible for the present network of the bus routes. The bus routes are continually converging and diverging as they weave in and out of each neighbourhood.

The third main determinant for bus route location is the distribution of population densities. If priorities were allocated for areas that must be served by bus, then high density areas would have a high priority and sparsely populated regions a low priority. The aim of these priorities being to have as an efficient bus route network as possible. The priorities would be different however, if the aim was to attract new bus riders from developing residential areas, which is the case particularly for traffic zones 1920 and 1930. The residential densities in these zones are not great and as yet the zones are not completely populated. Everybody living in these zones is within the mean walking distance to the bus stop.

It is interesting to compare the characteristics of the proposed bus route "P" with the existing bus network "E" and other proposed network "EP". The total population living within walking distance to this bus route is 32,375 which is 0.72 of the population within walking distance

to "E" and 0.65 of the population within walking distance to "EP". The total route street mileage for "P" is 25.2 miles, which is 0.69 of the route street miles for "E" and 0.49 of the route street miles for "EP". From the FIGURES D20 to D33 however, the mode splits calculated from each traffic zone for "P" are consistently the same if not greater than the mode splits calculated for the other two bus route networks.

As the mode splits calculated refer to the total traffic zone population and not only to the people living within the walking distance to the bus stop, then if the mode splits of "P" increased(or remained the same) and the people living within walking distance to the bus stop decreased, it could only infer a greater proportion of these people would be prepared to take the bus. As mentioned previously bus route "P" passes through or within walking distance to some of the highest residential density districts in the area north of 127th Avenue, which accounts for it having the highest ratio of population within walking distance, to route street miles, of 1280 compared to 1210 for "E" and 970 for "EP".

The locations of the bus routes in network "E" are interesting because there is a distinct difference in their spacing when the bus routes west of 97th Street are compared with the bus routes east of 97th Street. The average spacing of the bus routes west of 97th Street is 2,800 feet, while for the bus routes east of 97th Street the spacing ranges from 900 feet to 2,500 feet. The optimum spacing of bus routes determined in this thesis was 2,000 feet which means that the bus routes west of 97th Street are only slightly too far apart, while the bus routes east of 97th Street are much too close together.

When the average mode split and population density ratios are determined for zones west of 97th Street (1310, 1320, 1330 and 1340) and for zones east of 97th Street (1410, 1421, 1431 and 1440) it is interesting to see that there is only a small difference between them (see TABLE V-10). This means that the zones east of 97th Street could be supplied with a similar level of service, if the bus routes had been spaced further apart, with the actual location of the bus routes depending on the population distribution for each zone.

TABLE V-10

AVERAGE MODE SPLIT AND POPULATION DENSITY RATIOS FOR ZONES EAST AND WEST OF 97TH STREET

	Average Mode Split to each Destination Zone			
	0010	0020	0040	0060
Zones west of 97 St.	35	38	28	30
Zones east of 97 St.	38	38	25	21
Difference	3	0	3	9
	Average Population Density Ratio to each Destination Zone			
Zones west of 97 St.	0.78	0.78	0.78	0.78
Zones east of 97 St.	0.86	0.86	0.86	0.86
Difference	0.08	0.08	0.08	0.08

PLANNING RECOMMENDATIONS

Planning implications which have resulted from this thesis are listed below. Although these recommendations are directed primarily at the peak hour bus service, they are objectives to be obtained for any bus service.

1. For maximum efficiency in bus route location, the population density should vary inversely as the distance from the bus route increases. This means that high density development should be located as close as possible to the bus route.
2. Every effort should be made to reduce total travel time. This could be achieved by:
   (a) Reduce walking time to and from the bus stop by giving careful consideration to the location of bus routes and bus stops, as previously discussed.
   (b) Reduce waiting time by publishing and displaying easily understandable bus schedules.
   (c) Reduce actual travel time by having the bus routes follow as direct a route as possible from origin zones to destination zones, and eliminate transfers or keep transfer time to a minimum.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The aim of this thesis has been to investigate the relationship between bus route location, mode split, total travel time factors, excess time factors and population within walking distance to the bus stop, and subsequently to determine whether these relationships could be used to recommend the location of a particular bus route. Three bus routes were considered in the analysis.

Two methods were used for calculating bus travel times, Halls' Minimum Path Method and a Field Method, developed here, which averaged the time between the bus stops in the origin zone and bus stops in the destination zone. The bus times for the Field Method were generally higher than the bus times for the Minimum Path Method. The Field Method gives the more realistic time because it takes into account the time from every bus stop in the origin zone to every bus stop in the destination zone. However this method could be further improved by weighting the time from each bus stop in proportion to the number of people catching the bus at each bus stop; and thus obtain a time which is more representative to the people taking the bus.

For the bus times calculated by the Minimum Path Method, the excess times calculated by Rhyason were used, while for the bus times determined from the Field Method an interview survey was used to find waiting and walking times. This method generally produced excess times which were lower than those determined by Rhyason. The procedure of finding excess times from an interview survey is recommended because the

data is obtained from a sample of the people who actually ride the bus.

The three bus route networks used to test each of the above factors were the existing network and two proposed networks. Each network was designed to serve the area north of 127th Avenue in Edmonton. A measure of efficiency that was found to be useful was the ratio of population within walking distance to the bus stop (determined to be 1000 feet in this study) divided by both the total population of the zone and the bus route street miles in that zone. The higher this ratio, the more efficient the bus route was considered to be. However this ratio was not a measure of service in that for a particular level of efficiency the actual area served by the bus routes could vary greatly. From comparing the population ratios and efficiency ratios for each bus route network the existing bus route network was found to give a greater level of service.

From the graphs of mode split for a particular origin destination zone combination, proposed bus route "P" and "EP" would give on the average increased mode split for destination zones "0010" and "0020" and decreased mode split to destination zones "0040" and "0060".

No attempt has been made to weight bus excess time factors or total travel time as this would involve determining people's attitudes to these factors. If for example people weight more heavily waiting time than walking time then a bus network of wider spaced routes with a very frequent service would be more desirable than a network of closely spaced routes and an infrequent service.

The analysis of excess bus time and total bus travel time was concerned with time to and from the bus stop, however as bus stops are spaced at approximately 1000 feet (2 blocks) and walking distance to the

bus stop was also 1000 feet (2 blocks), the optimum spacing of bus routes then is 2000 feet (4 blocks). Although in many cases, bus route spacing is controlled by such factors as street pattern and population density, these dimensions are a useful guide.

RECOMMENDATIONS

The following recommendations are proposed,

(i) The effect on bus route location, of bus and car operating costs, and the travel time costs of people travelling to work should be investigated.

(ii) A better understanding of bus excess time, such as waiting and walking times, for other than the morning peak period, would be useful in determining bus route spacing and bus scheduling for that period. It was found that bus waiting time in the morning peak period was only 3.88 minutes, on the average. This may not be the case during the mid-day period.

(iii) Of the two methods used to calculate bus travel times, Halls' Minimum Path Method uses the zone centroid, which is the center of gravity of the dwelling units in the zone, while the Field Method only considers bus stops. It would be quicker and more convenient to use the center of gravity of the bus stops, and still have the same accuracy as was obtained from the Field Method.

(iv) The effect of different multi-family dwelling structural types or bus route locations should be further studied. Areas of walk-up apartments may have a different demand per dwelling unit for bus transit than does an area of high-rise apartments or basement suites.

(v) Future use of the Field Method to obtain bus times should weight the time from the bus stops in proportion to the number of people catching the bus at each bus stop.

(vi) Before the R ratio, as derived in this study, is used as a design aid in establishing location of bus routes, further study is needed to fully understand its limitations, and to find out whether it could be related to level of service.

LIST OF REFERENCES

1. The Eno Foundation for Highway Traffic Control, "Elementary Sampling for Traffic Engineers", Jangatuck, Connecticut, 1962.

2. Halls, C.R.G., "Transit Network Analysis by Reiteration of Mode Split Relationships", Faculty of Graduate Studies, University of Alberta, Edmonton, 1968.

3. Highway Research Record, "Passenger Transportation", No. 197, Washington, 1967.

4. Highway Research Record, "Origin and Destination Characteristics", No. 205, Washington, 1967.

5. Hill, D.M., Bakker, J.J., Aker, B.L., "An Evaluation of the Needs of the Pedestrian in Downtown", Traffic Research Corporation, January, 1964.

6. Lapin, Howard S., "Structuring the Journey to Work", University of Pennsylvania Press, 1964.

7. Meyer, J.R., Kain, J.F., Wohl, M.W., "The Urban Transportation Problem", Cambridge, Harvard University Press, 1965.

8. Oi, W.Y., Shuldiner, P.W., "An Analysis of Urban Travel Demands", Northwestern University Press, 1962.

9. Rhyason, D.B., "An Investigation into the Modal Split Relationships in the City of Edmonton", Faculty of Graduate Studies, University of Alberta, Edmonton, 1967.

10. Stuart, A. "Basic Ideas of Scientific Sampling", Charles Griffin and Company Ltd., London, 1962.

11. U.S. Department of Commerce, Bureau of Public Roads, "Traffic Assignment Manual", Government Printing Office, Washington, D.C., 1964.

APPENDIX A

BUS TIMES

TABLE A1

TRANSIT TRAVEL AND EXCESS TIMES TO ZONE 0010

USING MINIMUM PATH METHOD FOR TRAVEL TIMES

Origin Zone	Running Transfer, and Walking to Dest. Time	Transfer and Walking to Dest. Time	Running Time Only	Time Adjusted between Old & New Centroids	Adjusted Running Time to New Dest. Centroids	Excess Time: Walking to Origin	Excess Time: Waiting	Excess Time: Walking to Dest. & Transfer	Total Excess Time
1 a	2	3	4	5	6	7	8	9	10
0210	10.8	1.8	9.0	-1.6	7.4	3.6	2.5	3.9	10.0
0220	14.0	3.2	10.8	-1.6	9.2	3.4	2.5	3.9	9.8
0230	14.2	3.3	10.9	-1.6	9.3	3.9	3.9	3.9	11.7
0240	16.0	2.3	13.7	-1.6	12.1	2.7	3.9	3.9	10.5
0250	12.3	2.8	9.5	-1.6	7.9	3.9	3.9	3.9	11.7
0260	19.3	2.3	17.0	-1.6	15.4	3.4	2.5	3.9	9.8
0340	15.1	3.4	11.7	-1.6	10.1	3.1	1.3	3.9	8.3
0430	19.2	2.2	17.0	+1.6	18.6	3.4	2.5	3.9	9.8
0440	22.3	3.0	19.3	1.6	20.9	4.8	2.5	3.9	11.2
0510	16.3	2.7	13.6	1.6	15.2	3.4	1.3	3.9	8.6
0520	22.4	2.5	19.9	1.6	21.5	3.1	3.0	3.9	10.0
0540	21.7	2.2	19.5	1.6	21.1	4.0	3.9	3.9	12.4
0550	28.2	2.6	25.6	1.6	27.2	4.4	3.9	3.9	12.2
0560	20.7	3.4	17.3	-1.6	15.7	3.7	2.5	3.9	10.1
0710	21.7	2.5	19.2	-1.6	17.6	4.4	3.9	3.9	12.2
0720	24.1	3.1	21.0	-1.6	19.4	3.6	2.5	3.9	10.0
0730	16.8	2.9	13.9	-1.6	12.3	3.4	2.0	3.9	9.3
0810	31.0	2.5	28.5	-1.6	26.9	2.9	3.9	3.9	10.7
0820	30.0	1.6	28.4	-1.6	26.8	4.6	3.9	3.9	12.4
0830	28.2	3.0	25.2	-1.6	23.6	4.8	3.9	3.9	12.6
0860	16.9	3.3	13.6	-1.6	12.0	5.8	3.9	3.9	13.6
0870	22.8	3.5	19.3	-1.6	17.7	3.9	3.9	3.9	11.7
0880	26.0	3.8	22.2	-1.6	20.6	4.8	3.9	3.9	12.4
1150	33.7	3.0	30.7	-1.6	29.1	4.0	3.9	3.9	11.6
1160	25.7	3.2	22.5	-1.6	20.9	3.0	3.9	3.9	10.8
1170	29.7	3.2	26.5	-1.6	24.9	2.0	3.9	3.9	9.8
1310	21.8	3.7	18.1	+1.6	19.7	3.1	3.9	3.9	10.9
1320	23.7	3.7	20.0	+1.6	21.6	2.6	3.9	3.9	10.4
1330	29.4	3.2	26.2	-1.6	24.6	1.9	3.9	3.9	9.7
1340	25.8	3.1	22.7	-1.6	21.1	3.7	3.9	3.9	11.5
1410	21.4	3.1	18.3	-1.6	16.7	4.2	3.9	3.9	12.0
1421	NO	1967		FIGURES	AVAILABLE				

a. see explanations for those Tables page A10

TABLE A1 (cont')

TRANSIT TRAVEL AND EXCESS TIMES TO ZONE 0010

USING MINIMUM PATH METHOD FOR TRAVEL TIMES

Origin Zone	Running Transfer, and Walking to Dest. Time	Transfer and Walking to Dest. Time	Running Time Only	Time Adjusted between Old & New Centroids	Adjusted Running Time to New Dest. Centroids	Excess Time: Walking to Origin	Excess Time: Waiting	Excess Time: Walking to Dest. & Transfer	Total Excess Time
1	2	3	4	5	6	7	8	9	10
1431	NO	1967		FIGURES	AVAILABLE				
1440	30.6	3.0	27.6	+1.6	29.2	2.7	3.9	3.9	10.5
1520	27.0	3.6	23.4	+1.6	25.0	3.9	3.9	3.9	10.8
1620	27.0	2.0	25.0	+1.6	26.6	6.0	3.9	3.9	13.8
1630	23.2	2.0	21.2	+1.6	22.8	0.9	3.9	3.9	8.7
1920	NO	1967		FIGURES	AVAILABLE				
1930	NO	1967		FIGURES	AVAILABLE				
1940	NO	1967		FIGURES	AVAILABLE				

TABLE A2

TRANSIT TRAVEL AND EXCESS TIMES TO ZONE 0020

USING MINIMUM PATH METHOD FOR TRAVEL TIMES

Origin Zone	Running Transfer, and Walking to Dest. Time	Transfer and Walking to Dest. Time	Running Time Only	Time Adjusted between Old & New Centroids	Adjusted Running Time to New Dest. Centroids	Excess Time: Walking to Origin	Excess Time: Waiting	Excess Time: Walking to Dest. & Transfer	Total Excess Time
1 [a]	2	3	4	5	6	7	8	9	10
0210	10.8	1.8	9.0	-1.6	7.4	3.6	2.5	3.2	9.3
0220	14.0	3.2	10.8	-1.6	9.2	3.4	2.5	3.2	9.1
0230	14.2	3.3	10.9	-1.6	9.3	3.9	3.9	3.2	11.0
0240	16.0	2.3	13.7	-1.6	12.1	2.7	3.9	3.2	9.8
0250	12.3	2.8	9.5	-1.6	7.9	3.9	3.9	3.2	11.0
0260	19.3	2.3	17.0	-1.6	15.4	3.4	2.5	3.2	9.1
0340	15.1	3.4	11.7	-1.6	10.1	3.1	1.3	3.2	7.6
0430	19.2	2.2	17.0	+1.6	18.6	3.4	2.5	3.2	9.1
0440	22.3	3.0	19.3	+1.6	20.9	4.8	2.5	3.2	10.5
0510	16.3	2.7	13.6	+1.6	15.2	3.4	1.3	3.2	7.9
0520	22.4	2.5	19.9	+1.6	21.5	3.1	3.0	3.2	9.3
0540	21.7	2.2	19.5	+1.6	21.1	4.0	3.9	3.2	11.7
0550	28.2	2.6	25.6	1.6	27.2	4.4	3.9	3.2	11.5
0560	20.7	3.4	17.3	-1.6	15.7	3.7	2.5	3.2	9.4
0710	21.7	2.5	19.2	-1.6	17.6	4.4	3.9	3.2	11.5
0720	24.1	3.1	21.0	-1.6	19.4	3.6	2.5	3.2	9.3
0730	16.8	2.9	13.9	-1.6	12.3	3.4	2.0	3.2	8.6
0810	31.0	2.5	28.5	-1.6	26.9	2.9	3.9	3.2	10.0
0820	30.0	1.6	28.4	-1.6	26.8	4.6	3.9	3.2	11.7
0830	28.2	3.0	25.2	-1.6	23.6	4.8	3.9	3.2	11.9
0860	16.9	3.3	13.6	-1.6	12.0	5.8	3.9	3.2	12.9
0870	22.8	3.5	19.3	-1.6	17.7	3.9	3.9	3.2	11.0
0880	26.0	3.8	22.0	-1.6	20.6	4.8	3.9	3.2	11.7
1150	33.7	3.0	30.7	-1.6	29.1	4.0	3.9	3.2	10.9
1160	25.7	3.2	22.5	-1.6	20.9	3.0	3.9	3.2	10.1
1170	29.7	3.2	26.5	-1.6	24.9	2.0	3.9	3.2	9.1
1310	21.8	3.7	18.1	+1.6	19.7	3.1	3.9	3.2	10.2
1320	23.7	3.7	20.0	+1.6	21.6	2.6	3.9	3.2	9.7
1330	29.4	3.2	26.2	-1.6	24.6	1.9	3.9	3.2	9.0
1340	25.8	3.1	22.7	-1.6	21.1	3.7	3.9	3.2	10.8
1410	21.4	3.1	18.3	-1.6	16.7	4.2	3.9	3.2	11.3
1421	NO	1967	FIGURES	AVAILABLE					

a see explanations for those Tables page A10

TABLE A2 (cont')

TRANSIT TRAVEL AND EXCESS TIMES TO ZONE 0020

USING MINIMUM PATH METHOD FOR TRAVEL TIMES

Origin Zone	Running Transfer, and Walking to Dest. Time	Transfer and Walking to Dest. Time	Running Time Only	Time Adjusted between Old & New Centroids	Adjusted Running Time to New Dest. Centroids	Excess Time: Walking to Origin	Excess Time: Waiting	Excess Time: Walking to Dest. & Transfer	Total Excess Time
1	2	3	4	5	6	7	8	9	10
1431	NO	1967		FIGURES	AVAILABLE				
1440	30.6	3.0	27.6	+1.6	29.2	2.7	3.9	3.2	9.8
1520	27.0	3.6	23.4	+1.6	25.0	3.9	3.9	3.2	10.1
1620	27.0	2.0	25.0	+1.6	26.6	6.0	3.9	3.2	13.1
1630	23.2	2.0	21.2	+1.6	22.8	0.9	3.9	3.2	8.0
1920	NO	1967		FIGURES	AVAILABLE				
1930	NO	1967		FIGURES	AVAILABLE				
1940	NO	1967		FIGURES	AVAILABLE				

TABLE A3

TRANSIT TRAVEL AND EXCESS TIMES TO ZONE 0040

USING MINIMUM PATH METHOD FOR TRAVEL TIMES

Origin Zone	Running Transfer, and Walking to Dest. Time	Transfer and Walking to Dest. Time	Running Time Only	Time Adjusted between Old & New Centroids	Adjusted Running Time to New Dest. Centroids	Excess Time: Walking to Origin	Excess Time: Waiting	Excess Time: Walking to Dest. & Transfer	Total Excess Time
1 [a]	2	3	4	5	6	7	8	9	10
0210	18.6	4.50	14.1	0	14.1	3.6	2.5	4.5	10.6
0220	21.8	4.50	17.3	0	17.3	3.4	2.5	4.5	10.4
0230	22.0	4.50	17.5	0	17.5	3.9	3.9	4.5	12.3
0240	23.8	4.5	19.3	0	19.3	2.7	3.9	4.5	11.1
0250	20.1	7.0	13.1	0	13.1	3.9	3.9	7.0	14.8
0260	27.1	6.0	21.1	0	21.1	3.4	2.5	6.0	11.9
0340	10.8	5.2	5.6	0	5.6	3.1	1.3	5.2	9.6
0430	24.0	4.5	19.5	0	19.5	3.4	2.5	4.5	10.4
0440	27.1	4.5	22.6	0	22.6	4.8	2.5	4.5	11.8
0510	21.1	3.8	17.3	0	17.3	3.4	1.3	3.8	8.5
0520	27.2	4.2	23.0	0	23.0	3.1	3.0	4.2	10.3
0540	26.5	5.6	20.9	0	20.9	4.6	3.9	5.6	14.1
0550	33.0	5.4	27.6	0	27.6	4.4	3.9	5.4	13.7
0560	28.5	6.6	21.9	0	21.9	3.7	2.5	6.6	12.8
0710	29.5	4.6	24.9	0	24.9	4.4	3.9	4.6	12.9
0720	19.8	4.6	15.2	0	15.2	3.6	2.5	4.6	10.7
0730	14.4	3.2	11.2	0	11.2	3.4	2.0	3.2	8.6
0810	28.6	4.6	24.0	0	24.0	2.9	3.9	4.6	11.4
0820	27.6	5.0	22.6	0	22.6	4.6	3.9	5.0	13.5
0830	25.8	5.0	20.8	0	20.8	4.8	3.9	5.0	13.7
0860	24.7	5.4	19.3	0	19.3	5.8	3.9	5.4	15.1
0870	30.6	7.0	23.6	0	23.6	3.9	3.9	7.0	14.8
0880	24.6	5.0	19.6	0	19.6	4.8	3.9	5.0	13.7
1150	34.2	3.0	31.2	0	31.2	4.0	3.9	3.0	10.9
1160	26.2	3.0	23.2	0	23.2	3.0	3.9	3.0	9.9
1170	30.2	3.0	27.2	0	27.2	2.0	3.9	3.0	8.9
1310	19.6	6.0	13.6	0	13.6	3.1	3.9	6.0	13.0
1320	21.5	6.0	15.5	0	15.5	2.6	3.9	6.0	12.5
1330	37.2	6.0	31.2	0	31.2	1.9	3.9	6.0	11.8
1340	33.6	6.0	27.6	0	27.6	3.7	3.9	6.0	13.6
1410	29.2	6.0	23.2	0	23.2	4.2	3.9	6.0	14.1
1421	NO	1967	FIGURES		AVAILABLE				

a see explanations for those Tables page A10

TABLE A3 (cont')

TRANSIT TRAVEL AND EXCESS TIMES TO ZONE 0040

USING MINIMUM PATH METHOD FOR TRAVEL TIMES

Origin Zone	Running Transfer, and Walking to Dest. Time	Transfer and Walking to Dest. Time	Running Time Only	Time Adjusted between Old & New Centroids	Adjusted Running Time to New Dest. Centroids	Excess Time			Total Excess Time
						Walking to Origin	Waiting	Walking to Dest. & Transfer	
1	2	3	4	5	6	7	8	9	10
1431	NO	1967	FIGURES		AVAILABLE				
1440	28.4	7.0	21.4	0	21.4	2.7	3.9	7.0	13.6
1520	31.9	6.0	25.9	0	25.9	3.9	3.9	6.0	13.8
1620	31.8	5.0	26.8	0	26.8	6.0	3.9	5.0	19.9
1630	28.0	5.0	23.0	0	23.0	0.9	3.9	5.0	9.8
1920	NO	1967	FIGURES		AVAILABLE				
1930	NO	1967	FIGURES		AVAILABLE				
1940	NO	1967	FIGURES		AVAILABLE				

TABLE A4

TRANSIT TRAVEL AND EXCESS TIMES TO ZONE 0060

USING MINIMUM PATH METHOD FOR TRAVEL TIMES

Origin Zone	Running Transfer, and Walking to Dest. Time	Transfer and Walking to Dest. Time	Running Time Only	Time Adjusted between Old & New Centroids	Adjusted Running Time to New Dest. Centroids	Excess Time: Walking to Origin	Excess Time: Waiting	Excess Time: Walking to Dest. & Transfer	Total Excess Time
1 [a]	2	3	4	5	6	7	8	9	10
0210	22.9	6.0	16.9	0	16.9	3.6	2.5	6.0	12.1
0220	26.1	6.0	20.1	0	20.1	3.4	2.5	6.0	11.9
0230	26.3	6.0	20.3	0	20.3	3.9	3.9	6.0	13.8
0240	28.1	5.0	23.1	0	23.1	2.7	3.9	5.0	11.6
0250	24.4	5.0	19.4	0	19.4	3.9	3.9	5.0	12.8
0260	31.4	8.0	24.4	0	24.4	3.4	2.5	8.0	13.9
0340	12.1	6.0	6.1	0	6.1	3.1	1.3	6.0	10.4
0430	28.3	6.0	22.0	0	22.0	3.4	2.5	6.0	11.9
0440	31.4	5.0	26.4	0	26.4	4.8	2.5	5.0	12.3
0510	25.4	7.0	18.4	0	18.4	3.4	1.3	7.0	11.7
0520	31.5	6.0	25.5	0	25.5	3.1	3.0	6.0	12.1
0540	30.8	5.6	25.2	0	25.2	4.6	3.9	5.6	14.1
0550	37.3	5.4	31.9	0	31.9	4.4	3.9	5.4	13.7
0560	32.8	5.4	27.4	0	27.4	3.7	2.5	5.4	11.6
0710	33.8	4.0	29.8	0	29.8	4.4	3.9	4.0	12.3
0720	21.1	4.0	17.1	0	17.1	3.6	2.5	4.0	10.1
0730	22.7	5.0	17.7	0	17.1	3.4	2.0	5.0	10.4
0810	36.9	6.0	30.9	0	30.9	2.9	3.9	6.0	12.8
0820	35.9	6.0	29.9	0	29.9	4.6	3.9	6.0	14.5
0830	34.1	6.0	28.1	0	28.1	4.8	3.9	6.0	14.7
0860	29.0	8.0	21.0	0	21.0	5.8	3.9	8.0	17.7
0870	34.9	8.0	26.9	0	26.9	3.9	3.9	8.0	15.8
0880	32.9	8.0	24.9	0	24.9	4.8	3.9	8.0	16.7
1150	42.5	8.0	34.5	0	34.5	4.0	3.9	8.0	15.9
1160	34.5	8.0	26.5	0	26.5	3.0	3.9	8.0	14.9
1170	38.5	8.0	30.5	0	30.5	2.0	3.9	8.0	13.9
1310	22.4	5.0	17.4	0	17.4	3.1	3.9	5.0	12.0
1320	24.3	5.0	19.3	0	19.3	2.6	3.9	5.0	11.5
1330	45.0	5.0	40.0	0	40.0	1.9	3.9	5.0	10.8
1340	41.5	5.0	36.4	0	36.4	3.7	3.9	5.0	12.6
1410	37.0	5.0	32.0	0	32.0	4.2	3.9	5.0	13.1
1421	NO	1967	FIGURES	AVAILABLE					

a see explanations for those Tables page A10

TABLE A4 (cont')

TRANSIT TRAVEL AND EXCESS TIMES TO ZONE 0060

USING MINIMUM PATH METHOD FOR TRAVEL TIMES

Origin Zone	Running Transfer, and Walking to Dest. Time	Transfer and Walking to Dest. Time	Running Time Only	Time Adjusted between Old & New Centroids	Adjusted Running Time to New Dest. Centroids	Excess Time: Walking to Origin	Excess Time: Waiting	Excess Time: Walking to Dest. & Transfer	Total Excess Time
1	2	3	4	5	6	7	8	9	10
1431	NO	1967	FIGURES		AVAILABLE				
1440	31.2	5.0	16.2	0	16.2	2.7	3.9	5.0	11.6
1520	36.1	8.0	28.1	0	28.1	3.9	3.9	8.0	15.8
1620	36.1	6.0	30.1	0	30.1	6.0	3.9	6.0	15.9
1630	32.3	6.0	26.3	0	26.3	0.9	3.9	6.0	10.8
1920	NO	1967	FIGURES		AVAILABLE				
1930	NO	1967	FIGURES		AVAILABLE				
1940	NO	1967	FIGURES		AVAILABLE				

Explanation of Tables (A1 - A4)

Column 1	-	Zone from which trip to C.B.D. originated.
" 2	-	Running time, transfer time, and time taken to walk to final destination. This time is taken directly from Halls' minimum path program.
" 3	-	Transfer and walking to destination times from Rhyason's excess time figures.
" 4	-	Bus running time only; obtained by subtracting the time in Column 3 from the time in Column 2.
" 5	-	Because the destination zone centroids in this thesis are different from those used by Halls, adjustment was necessary to Halls times in Column 2. The time in this column gives the difference in running time from the bus stops closest to Halls' centroid and the centroid used here. Adjustment was only necessary, however, between Halls' zone "0010+0020" and the two separate zones "0010" and "0020". See explanation for this in chapter on "Data Collection - Traffic Zones."
" 6	-	By combining the running time in Column 4 with the time adjustment in Column 5, gives the adjusted running time in this column.
" 7	-	Walking to origin time from Rhyason's excess time data.
" 8	-	Waiting time from Rhyason's excess time data. The maximum waiting time used here is 3.9 minutes instead of 5.0 minutes used by Rhyason. This is to agree with the average waiting time found in the interview survey.

Column 9 - Sum of walking to destination time and transfer time. The walking to destination time is the time taken to walk from the bus stop closest to the zone centroid. For zone "0010" this time is 3.9 minutes and for zone "0020" it is 3.2 minutes.

" 10 - Total excess time, which is the sum of the excess times in columns 7, 8 and 9.

TABLE A5

RIDING TIME CHECK DATA FOR AREA NORTH OF 127 AV.

Bus Route	Bus Stop Location	Bus times measured from Reference Destination Number 1 (minutes and seconds) Trip 1	Trip 2	Trip 3	Trip 4	Average Route Time Starting & Finishing at Ref.Dest.No.1
1 [a]	2	3	4	5	6	7
N4	5148	4-57				35
N4	3132		8-50			35
N4	3133	9-25				35
N4	2042	11-42	11-29			35
N4	2043	12-45	13-14			35
N4	2044	13-29				35
N4	2134	14-16				35
N4	3135	16-55	14-55			35
N4	3136	17-39	16-02			35
N4	3137	18-51	17-01			35
N4	3138	19-56	18-03			35
N4	4139	20-46	18-35			35
N4	4140	21-26	9-13			35
N4	4141	22-18	20-10			35
N4	4142	23-29	20-53			35
N4	5143		21-50			35
N4	5149	24-16				35
N4	5144	25-15	23-05			35
N4	5154	26-25	24-10			35
N4	5146	27-30	25-00			35
N4	5107	28-35				35
N5	5125		5-30	8-10		36
N5	4124			9.00		36
N5	4123		6-25			36
N5	4122			10-20		36
N5	4121		7-20	11-00		36
N5	3120			11-50		36
N5	3119		8-30	12-35		36
N5	3118	11-37	9-10	13-20		36
N5	2117		9-55	14-15		36
N5	2024	13-06	11-00	15-05		36
N5	2025	16-30	12-45	19-35		36
N5	2026		13-45	20-20		36
N5	2116	17-54	14-34	22-05		36
N5	3115			22-50		36
N5	3114	19-41	15-40	23-20		36

a see explanations for these Tables page A17

TABLE A5 (cont')

RIDING TIME CHECK DATA FOR AREA NORTH OF 127 AV.

Bus Route	Bus Stop Location	Bus times measured from Reference Destination Number 1 (minutes and seconds) Trip 1	Trip 2	Trip 3	Trip 4	Average Route Time Starting & Finishing at Ref.Dest.No.1
1	2	3	4	5	6	7
N5	3113	20-39	16-20	24-00		36
N5	3112	21-26	16-55	24-10		36
N5	4111	22-40	18-10	25-35		36
N5	4110	23-28	18-50	26-20		36
N5	4147	27-07	19-40			36
N5	4109	25-04	20-25	27-15		36
N5	4108	26-05	21-35	29-20		36
N5	5107	27-40	24-10			36
N6	1008	5-00				30
N6	1012	8-00		5-10		30
N6	1013		10-00			30
N6	1015			9-05		30
N6	1017			10-20		30
N6	1018	13-00	12-00			30
N6	1019		13-00	12-00		30
N6	1020	14-00	14-00	12-35		30
N6	1021	15-00	14-00			30
N6	2022	16-00	15-00	13-14		30
N6	2023	17-00	16-00	13-34		30
N6	2024			14-04		30
N6	2025	18-00	19-00	15-39		30
N6	2026		19-00			30
N6	2027	20-00	20-00	17-09		30
N6	2028	21-00	21-00			30
N6	2029			19-04		30
N6	1030	22-00	22-00	19-41		30
N6	1031	23-00		20-14		30
N7	2007		4-30	3-50		30
N7	2037		5-00	4-40		30
N7	2038			5-25		30
N7	2039	6-25				30
N7	2040		6-20	6-20		30
N7	2041			6-45		30
N7	2043		7-40			30
N7	2044		8-20			30
N7	2045	8-10	8-45	8-45		30

TABLE A5 (cont')

RIDING TIME CHECK DATA FOR AREA NORTH OF 127 AV.

Bus Route	Bus Stop Location	Bus times measured from Reference Destination Number 1 (minutes and seconds) Trip 1	Trip 2	Trip 3	Trip 4	Average Route Time Starting & Finishing at Ref.Dest.No.1
1	2	3	4	5	6	7
N7	2046		9-20	9-30		30
N7	1047	9-40	10-15	10-40		30
N7	1048			11-15		30
N7	1049			12-35		30
N7	1050		12-00	13-35		30
N7	1051	12-10	12-40	16-00		30
N7	1052	13-20	13-30			30
N7	1053	14-40	14-20			30
N7	1054	15-40	15-25			30
N7	1055	16-40				30
N7	1056	17-10	16-40			30
N7	1057	18-05	17-30	17-20		30
N7	1058	19-40	18-30			30
N7	1059	20-30	19-30	19-30		30
N7	1060	21-25	20-10			30
N7	1030	22-10	20-50	20-05		30
N7	1031	22-55	22-20			30
N8	7306	7-36	9-30	9-06	10-00	26
N8	7307		10-30	9-58	10-40	26
N8	7308	10-05	11-15	10-40	11-23	26
N8	7309	11-06	12-20	12-00	12-15	26
N8	7310			13-30	13-30	26
N8	7311	12-48	13-55	14-35	14-15	26
N8	7312	14-07	15-05		15-13	26
N8	7313		15-50	18-35	15-55	26
N8	7314	15-47	16-53	19-23	16-55	26
N8	7315	16-43	17-47	20-08	17-43	26
N8	7316	17-52	19-08	21-03	18-45	26
N8	6212	19-07	20-10	22-13	19-32	26
N8	6317	20-00	21-05	23-12	20-18	26
N8	6318	20-51	21-50	23-58	21-08	26
N9	8402	6-26	7-24			15
N9	8403	6-56	7-51	8-58		15
N9	8404	7-26	9-09	10-57		15
N9	8602	8-11	10-04	11-47		15
N9	8603	8-36		12-22		15

TABLE A5 (cont')

RIDING TIME CHECK DATA FOR AREA NORTH OF 127 AV.

Bus Route	Bus Stop Location	Bus times measured from Reference Destination Number 1 (minutes and seconds) Trip 1	Trip 2	Trip 3	Trip 4	Average Route Time Starting & Finishing at Ref.Dest.No.1
1	2	3	4	5	6	7
N9	8604		10-44	12-57		15
N9	8605	9-06	11-06	12-16		15
N9	8606		11-51	12-59		15
N9	8607	11-05	12-46	13-57		15
N9	8608	11-48				15
N9	8609	14-15	14-58			15
N9	8610	12-27	15-33	15-41		15
N10	6221		2-40			29
N10	6223	10-45				29
N10	7224	5-50	5-10			29
N10	7225	6-35	6-05			29
N10	7226	7-35	7-05			29
N10	7227	8-25	7-50			29
N10	7228	9-10	8-45			29
N10	5229	10-45	9-25			29
N10	5230	11-55	10-55			29
N10	5216	12-45	12-05			29
N10	5217	13-35	12-45			29
N10	5218	14-35	14-00			29
N10	5219	15-05	15-05			29
N10	5146	16-15	15-05			29
N11	5202			0-20		29
N11	5203				1-07	29
N11	5204				1-53	29
N11	7206			4-10		29
N11	7207	3-30	2-54			29
N11	7208		3-40	5-18	4-25	29
N11	7209	4-51		6-07	5-40	29
N11	7210	5-28	5-05	7-00	6-23	29
N11	7211	6-15	6-07	8-00	7-15	29
N11	6212	7-15	7-25	9-30	8-50	29
N11	6213	8-20	8-30	10-55	9-50	29
N11	6214	9-16	9-26	12-10	10-33	29
N11	6215	10-20	10-17	13-00	11-30	29
N11	5216	11-16	11-04	14-00	12-15	29
N11	5217	12-00	11-42	14-54		29

TABLE A5 (cont')

RIDING TIME CHECK DATA FOR AREA NORTH OF 127 AV.

Bus Route	Bus Stop Location	Bus times measured from Reference Destination Number 1 (minutes and seconds) Trip 1	Trip 2	Trip 3	Trip 4	Average Route Time Starting & Finishing at Ref.Dest.No.1
1	2	3	4	5	6	7
N11	5218	13-00	12-31	15-57		29
N11	5219	13-45	13-00	16-50		29
N11	5146	14-06	13-15	18-03		29
N12	10411	8-27				20.5
N12	10412	9-25	9-09	8-31		20.5
N12	10413	10-18	10-12			20.5
N12	10414	10-55	10-55	9-43		20.5
N12	10415	11-27				20.5
N12	10416	12-28	12-15	11-20		20.5
N12	10417	13-45	13-30	12-35		20.5
N12	10418	15-00	14-47	14-15		22.0
N12	9419	15-45	15-55			22.0
N12	7421	17-19		16-07		22.0
N12	6401	20-47	20-50	20-50		22.0
N13	9504	5-55	6-56			25
N13	9505	5-50	7-43			25
N13	9507	7-30	8-08	9-10		25
N13	9508	10-20				25
N13	9509	8-40	9-55	11-22		25
N13	9510			12-12		25
N13	9511			13-13		25
N13	9512	10-33	12-30	14-07		25
N13	9513	11-20		14-50		25
N13	9519	13-33	15-50	16-06		25
N13	7412			17-42		25
N13	6401	15-42	19-40			25
R3	6804	4-15		4-35		-
R3	6805	3-50	4-15			-
R3	6806	3-15	3-26	3-32		-
R3	6807	2-30	2-50			-
R3	6808	1-45	1-50	1-55		-
R3	6809	0-47	0-58	0-58		-
R4	5709	1-05	1-10	1-30		-
R4	5710	2-20	2-40			-

Explanation of Table A5

Column 1 - Bus routes giving service to the C.B.D. from north of 127th Avenue in Edmonton.

" 2 - Bus stop location. The last three digits refer to the bus stop number shown in FIGURE E1 and the digits immediately preceding these digits are coded zone numbers, as listed in TABLE A6.

" 3-6 - Bus times measured from Reference Destination Number 1. The times were only recorded at the locations the bus stopped to pick up passengers. (Time is given in minutes and seconds). For bus routes R3 and R4, the time given is for the time from a particular bus stop to the Reference Destination Number 1.

" 7 - This is the average time taken by the bus to travel the section of its route which starts and finishes at Reference Destination Number 1. Bus routes R3 and R4 do not have the feature of starting and finishing at a particular location, therefore this column is neglected for them.

TABLE A6

"CODED ZONE NUMBER"

Zone	Coded Zone Number	Zone	Coded Zone Number
1310	1	1431	7
1320	2	1440	8
1330	3	1920	9
1340	4	1930	10
1410	5	1940	11
1421	6	1950	12

DEFINITIONS USED IN FIELD METHOD

Reference Destination Number 1.

This refers to a location, not in the C.B.D. at which schedule times are listed in the Edmonton Transit System (E.T.S.) timetables. The unique feature of this location is that the bus stops there before collecting passengers north of 127th Avenue, and then stops again on its way to the C.B.D. after picking up passengers in the area.

It was from these locations that the riding time checks in the area were timed.

A list of the bus routes and their reference destinations are given in TABLE A7.

Reference Destination in the C.B.D.

This is the location in the C.B.D. listed in the bus timetables as the end of the route. Their location is also listed in TABLE A7.

TABLE A7

LIST OF REFERENCE DESTINATIONS

Bus Route	Ref.Dest. 1. St.	Ref.Dest. 1. Av.	Ref.C.B.D.Dest. St.	Ref.C.B.D.Dest. Av.	Schedule Time from Ref.Dest.1 to C.B.D.
N4	97	118	102	Jasper	15 min.
N5	97	118	102	Jasper	15 min.
N6	124	118	101	Jasper	15 min.
N7	124	118	101	Jasper	15 min.
N8	82	118	101	Jasper	16 min.[(a)]
N9	82	118	101	Jasper	15 min.
N10	97	128	102	Jasper	20 min.
N11	97	128	102	Jasper	20 min.
N12	66	127	101	Jasper	24 min.[(a)]
N13	66	127	101	Jasper	30 min.[(b)]
R3	66	127	101	Jasper	30 min.[(b)]
R4	97	135	102	Jasper	30 min.[(c)]

(a) Includes 1 minute transfer time.

(b) Includes 7 minutes transfer time.

(c) Includes 4 minutes transfer time.

TABLE A8

ANALYSIS OF TRIP TIME DATA IN NORTH EDMONTON FROM SPECIFIC BUS STOPS.

Bus Route	Bus Stop Location	Bus Running Time Only to C.B.D. Destination Zones (minutes)			
		0010	0020	0040	0060
(a) 1	2	3	4	5	6
N4	5148	41.99	49.01	51.97	55.90
N4	3132	38.11	45.13	48.09	52.02
N4	3133	37.52	44.54	47.50	51.43
N4	2042	35.35	42.37	45.33	49.26
N4	2043	33.91	40.97	43.93	47.86
N4	2044	33.46	40.48	43.44	47.37
N4	2134	32.67	39.69	42.65	46.58
N4	3135	31.02	38.04	41.00	44.93
N4	3136	30.10	37.12	40.08	44.01
N4	3137	29.01	36.03	38.99	42.92
N4	3138	27.95	34.97	37.93	41.86
N4	4139	27.26	34.29	37.25	41.18
N4	4140	31.61	38.63	41.60	45.52
N4	4141	25.71	32.73	35.69	39.62
N4	4142	24.76	31.78	34.78	38.67
N4	5143	25.11	32.13	35.09	39.02
N4	5149	22.67	29.69	32.65	36.58
N4	5144	22.77	29.79	32.75	36.68
N4	5154	21.65	28.67	31.63	35.56
N4	5146	20.69	27.71	30.67	34.60
N4	5107	18.36	25.38	28.34	32.27
N5	5125	41.11	48.13	51.09	55.02
N5	4124	38.94	45.96	48.92	52.85
N5	4123	41.52	48.54	51.50	55.43
N5	4122	37.61	44.63	47.59	51.52
N5	4121	38.77	45.79	48.75	52.68
N5	3120	36.11	43.13	46.09	50.02
N5	3119	37.40	44.42	47.38	51.31
N5	3118	36.57	43.59	46.55	50.48
N5	2117	35.86	42.88	45.84	49.77
N5	2024	34.88	41.90	44.86	48.79
N5	2025	31.66	38.68	41.64	45.57
N5	2026	30.90	37.92	40.88	44.81
N5	2116	29.76	36.78	39.74	43.67

(a) See explanations for these tables page A26

TABLE A8 (cont')

ANALYSIS OF TRIP TIME DATA IN NORTH

EDMONTON FROM SPECIFIC BUS STOPS.

Bus Route	Bus Stop Location	Bus Running Time Only to C.B.D. Destination Zones (minutes)			
		0010	0020	0040	0060
1	2	3	4	5	6
N5	3115	25.11	32.13	35.09	39.02
N5	3114	28.38	35.40	38.36	42.29
N5	3113	27.61	34.63	37.59	41.52
N5	3112	26.93	33.95	36.91	40.84
N5	4111	25.80	32.82	35.78	39.71
N5	4110	25.06	32.08	35.04	38.97
N5	4147	24.55	31.57	34.53	38.46
N5	4109	23.70	30.72	33.68	37.61
N5	4108	22.27	29.29	32.25	36.18
N5	5107	22.02	29.04	32.00	35.93
N6	1008	40.00	41.95	49.34	53.85
N6	1012	38.42	40.37	47.76	52.27
N6	1013	35.00	36.95	44.34	48.85
N6	1015	35.92	37.87	45.26	49.77
N6	1017	34.67	36.62	44.01	48.52
N6	1018	32.50	34.45	41.84	46.35
N6	1019	32.50	34.45	41.84	46.35
N6	1020	31.47	33.42	40.81	45.32
N6	1021	30.50	32.45	39.84	44.35
N6	2022	30.26	32.21	39.60	44.11
N6	2023	29.48	31.43	38.82	43.33
N6	2024	30.93	32.88	40.27	44.78
N6	2025	27.45	29.40	36.79	41.30
N6	2026	26.00	27.95	35.34	39.85
N6	2027	29.95	27.90	35.29	39.80
N6	2028	24.00	25.95	33.34	37.85
N6	2029	25.93	27.88	35.27	39.78
N6	1030	23.77	25.72	33.11	37.62
N6	1031	23.38	25.33	32.72	37.23
N7	2007	40.83	42.78	50.17	54.68
N7	2037	40.17	42.12	49.51	54.02
N7	2038	39.58	41.53	48.92	53.43
N7	2039	38.58	40.53	47.92	52.43
N7	2040	38.67	40.62	48.01	52.52
N7	2041	38.25	40.20	47.59	52.10
N7	2043	37.33	39.28	46.67	51.18
N7	2044	36.67	38.62	46.01	50.52

TABLE A8 (cont')

ANALYSIS OF TRIP TIME DATA IN NORTH

EDMONTON FROM SPECIFIC BUS STOPS.

Bus Route	Bus Stop Location	Bus Running Time Only to C.B.D. Destination Zones (minutes)			
		0010	0020	0040	0060
1	2	3	4	5	6
N7	2045	36.44	38.39	45.78	50.29
N7	2046	35.58	37.53	44.92	49.43
N7	1047	34.81	36.76	44.15	48.66
N7	1048	33.75	35.70	43.09	47.60
N7	1049	32.42	34.37	41.76	46.27
N7	1050	32.29	34.24	41.63	46.14
N7	1051	31.39	33.34	40.73	45.24
N7	1052	31.58	33.53	40.92	45.43
N7	1053	30.50	32.45	39.84	44.35
N7	1054	29.46	31.41	38.80	43.31
N7	1055	28.33	30.28	37.67	42.18
N7	1056	28.08	30.03	37.42	41.93
N7	1057	27.36	29.31	36.70	41.21
N7	1058	25.92	27.87	35.26	39.77
N7	1059	25.17	27.12	34.51	39.02
N7	1060	24.21	26.16	33.55	38.06
N7	1030	23.97	25.92	33.31	37.82
N7	1031	27.38	24.33	31.72	36.23
N8	7306	33.64	36.14	37.75	41.03
N8	7307	32.31	34.81	36.42	39.70
N8	7308	31.84	34.34	35.95	39.23
N8	7309	30.77	33.27	34.88	38.16
N8	7310	29.19	31.69	33.30	36.58
N8	7311	28.80	31.30	32.91	36.19
N8	7312	27.88	30.38	31.99	35.27
N8	7313	25.91	28.41	30.02	33.30
N8	7314	25.45	27.95	29.56	32.84
N8	7315	24.60	27.10	28.71	31.99
N8	7316	23.49	25.99	27.60	30.88
N8	6212	22.43	24.93	26.54	29.82
N8	6317	21.54	24.04	25.65	28.93
N8	6318	20.74	23.24	24.85	28.13
N9	8402	23.77	26.27	27.88	31.16
N9	8403	22.77	25.27	26.88	30.16
N9	8404	21.51	24.01	25.62	28.90
N9	8602	20.68	23.18	24.79	28.07
N9	8603	20.21	22.71	24.32	27.60
N9	8604	18.85	21.35	22.96	26.24

TABLE A8 (cont')

ANALYSIS OF TRIP TIME DATA IN NORTH

EDMONTON FROM SPECIFIC BUS STOPS.

Bus Route	Bus Stop Location	Bus Running Time Only to C.B.D. Destination Zones (minutes)			
		0010	0020	0040	0060
1	2	3	4	5	6
N9	8605	19.87	22.37	23.98	27.26
N9	8606	18.27	20.77	22.38	25.66
N9	8607	18.09	20.59	22.20	25.48
N9	8608	18.89	21.39	23.00	26.28
N9	8609	15.08	18.58	20.19	23.47
N9	8610	16.13	18.63	20.24	23.52
N10	6221	43.27	50.29	53.25	57.18
N10	6223	35.19	42.21	45.17	49.10
N10	7224	40.44	47.46	50.42	54.35
N10	7225	39.61	46.63	49.59	53.52
N10	7226	38.61	45.63	48.59	52.52
N10	7227	37.81	44.83	47.79	51.72
N10	7228	26.98	44.00	46.96	50.89
N10	5229	35.86	42.88	45.84	49.77
N10	5230	34.52	41.54	44.50	48.43
N10	5216	33.52	40.54	43.50	47.43
N10	5217	32.77	39.79	42.75	46.68
N10	5219	30.86	37.88	40.84	44.77
N10	5146	30.27	37.29	40.25	44.18
N11	5202	45.61	52.63	55.59	59.52
N11	5203	44.82	51.84	54.80	58.73
N11	5204	44.06	51.08	54.04	57.97
N11	7206	41.77	48.79	51.75	55.68
N11	7207	42.74	49.76	52.72	56.65
N11	7208	41.48	48.50	51.46	55.39
N11	7209	40.40	47.42	50.38	54.31
N11	7210	39.96	46.98	49.94	53.87
N11	7211	39.04	46.06	49.02	52.95
N11	6212	37.69	44.71	47.67	51.60
N11	6213	36.54	43.56	46.52	50.45
N11	6214	35.59	42.61	45.57	49.50
N11	6215	34.66	41.68	44.64	48.51
N11	5216	33.79	40.81	43.77	47.70
N11	5217	33.07	40.09	43.05	46.98
N11	5218	32.12	39.14	42.10	46.03
N11	5219	31.41	38.43	41.39	45.32
N11	5146	30.81	37.83	40.79	44.72

TABLE A8 (cont')

ANALYSIS OF TRIP TIME DATA IN NORTH

EDMONTON FROM SPECIFIC BUS STOPS.

Bus Route	Bus Stop Location	Bus Running Time Only to C.B.D. Destination Zones (minutes)			
		0010	0020	0040	0060
1	2	3	4	5	6
N12	10411	36.74	39.24	40.85	44.13
N12	10412	36.16	38.66	40.27	43.55
N12	10413	34.94	37.44	39.05	42.33
N12	10414	34.67	37.17	38.78	42.06
N12	10415	33.74	36.24	37.85	41.13
N12	10416	33.17	35.67	37.28	40.56
N12	10417	31.91	34.41	36.02	39.30
N12	10418	32.01	34.51	36.12	39.40
N12	9419	30.86	33.36	34.96	38.25
N12	7421	29.97	32.47	34.08	37.36
N12	6401	25.87	28.37	29.98	33.26
N13	9504	49.26	51.76	53.37	56.67
N13	9505	48.91	51.41	53.02	56.30
N13	9507	47.42	49.92	51.53	54.81
N13	9508	45.36	47.86	49.47	52.75
N13	9509	45.71	48.21	49.82	53.10
N13	9510	43.49	45.99	47.60	50.88
N13	9511	42.47	44.97	46.58	49.86
N13	9512	43.30	45.80	47.41	50.69
N13	9513	42.61	45.11	46.72	50.00
N13	9419	40.53	43.03	44.64	47.92
N13	7421	37.99	40.49	42.10	45.38
N13	6401	38.01	40.51	42.12	45.40
R3	6804	31.36	38.38	41.34	45.27
R3	6805	30.96	37.98	40.94	44.87
R3	6806	30.34	37.36	40.32	44.25
R3	6807	29.61	36.63	39.59	43.52
R3	6808	28.77	35.79	38.75	42.68
R3	6809	27.84	34.86	37.82	41.75
R4	5709	31.94	34.44	36.05	39.08
R4	5710	33.19	35.69	37.30	40.58

Explanations of Table A8

Column 1 - Bus Route Number

" 2 - Bus Stop Location. The last three digits refer to the bus stop number shown in FIGURE E1 and the digits immediately preceding these digits are coded zone numbers, as listed in TABLE A6.

3-6 - Bus Running Time Only to C.B.D. Destination Zones. These times also include transfer time.

TABLE A9

TOTAL AVERAGE TRAVEL TIME BETWEEN EACH ORIGIN ZONE AND EACH DESTINATION ZONE.

Origin Zone	Number of Bus Stops	Total Average Travel Time to CBD. Destination Zones (minutes) 0010	0020	0040	0060
1310	27	30.36	32.31	39.70	44.21
1320	27	33.36	37.00	42.91	47.23
1330	13	31.68	38.70	41.66	45.59
1340	13	29.81	36.83	39.79	43.72
1410	26	31.79	38.46	41.32	45.19
1421	17	31.20	36.88	39.45	43.19
1431	24	34.20	38.77	41.00	44.57
1440	12	19.59	22.09	23.70	26.98
1920	11	43.63	46.13	47.74	51.02
1930	8	34.17	36.67	38.28	41.56

TABLE A10

SUMMARY OF DATA COLLECTED FROM INTERVIEW SURVEY

Bus Route (a)	Bus Stop Location	Walking Distance from home to Bus Stop (ft)	Walking Distance from bus stop to Work (ft)	Waiting Time (min).	Sex M=Male F=Female	Knowledge of Bus Schedule
1	2	3	4	5	6	7
N4	4140	1530	840	3	M	Yes
		-	-	3	M	Yes
		-	-	3	F	Yes
		-	-	3	F	Yes
		1530	210	3	M	Yes
		700	2200	2	M	Yes
		-	-	2	M	Yes
		970	350	7	M	Yes
		970	140	7	M	Yes
		700	900	5	M	Yes
		560	1250	4	M	Yes
		1180	280	3	F	Yes
		70	2500	1	F	Yes
		1740	210	12	F	Yes
		700	140	2	F	Yes
		840	560	2	F	Yes
		840	140	12	F	Yes
		-	-	7	F	Yes
		840	970	2	M	Yes
		-	-	6	F	Yes
		840	2900	4	F	Yes
		-	-	3	M	No
		1250	140	2	F	Yes
		560	140	9	F	Yes
		-	-	7	F	Yes
		420	350	6	F	Yes
N5	3115	420	1110	8	M	Yes
		420	140	6	M	Yes
		770	970	4	M	Yes
		1040	1250	4	M	Yes
		-	-	2	F	Yes
		-	-	7	M	Yes
		1180	210	3	F	Yes
		-	-	2	M	No
		-	-	1	F	Yes
		490	900	1	M	Yes

(a) See explanations of table page A36

TABLE A10 (cont')

SUMMARY OF DATA COLLECTED FROM INTERVIEW SURVEY

Bus Route	Bus Stop Location	Walking Distance from home to Bus Stop (ft)	Walking Distance from Bus Stop to Work(ft)	Waiting Time (min).	Sex M=Male F=Female	Knowledge of Bus Schedule
1	2	3	4	5	6	7
		-	-	11	M	Yes
		-	-	8	F	Yes
		-	-	7	F	Yes
		210	140	6	F	Yes
		70	140	4	F	Yes
		280	900	3	F	Yes
		-	-	3	M	Yes
		-	-	3	F	Yes
		630	280	13	F	Yes
		700	140	8	F	Yes
		-	-	8	M	No
		-	-	2	F	Yes
N5	6119	625	-	5	F	Yes
		1670	-	2	M	Yes
		-	-	0	M	-
N6	1018	700	1800	8	F	Yes
		280	70	0	M	Yes
		350	-	4	M	Yes
		560	-	6	F	Yes
		700	560	4	F	Yes
		700	840	3	F	Yes
		770	210	1	F	Yes
N6	1021	840	-	10	M	Yes
		900	280	4	M	Yes
		1250	1670	2	M	Yes
		420	140	2	F	Yes
		420	210	2	M	Yes
		420	1670	2	F	Yes
		560	-	2	F	Yes
		1110	-	1	M	Yes
		420	140	3	F	Yes
		350	140	3	F	Yes
		4200	210	5	M	Yes
		210	280	2	M	Yes
		210	-	7	F	No

TABLE A10 (cont')

SUMMARY OF DATA COLLECTED FROM INTERVIEW SURVEY

Bus Route	Bus Stop Location	Walking Distance from home to Bus Stop (ft)	Walking Distance from Bus Stop to Work(ft)	Waiting Time (min).	Sex M=Male F=Female	Knowledge of Bus Schedule
1	2	3	4	5	6	7
N6	2025	900	140	4	M	Yes
		490	-	7	F	Yes
		1180	-	5	F	Yes
		420	-	3	M	Yes
		630	840	2	M	Yes
		630	350	10	F	Yes
		1460	140	10	F	Yes
		900	700	8	F	Yes
		350	-	5	F	Yes
		560	420	5	F	Yes
		560	830	3	F	Yes
		280	-	2	F	Yes
		700	350	3	F	Yes
		210	210	3	F	Yes
N7	1039	NO	-	REPLIES		
N7	1047	-	-	5	F	Yes
		-	-	5	F	Yes
N7	1054	280	-	1	M	Yes
		280	980	3	M	Yes
		560	980	3	M	Yes
		560	-	1	F	Yes
		560	-	1	M	Yes
		280	280	1	F	Yes
		280	-	9	F	Yes
		280	840	0	M	Yes
		280	1110	1	M	Yes
		560	210	1	F	Yes
N7	1055	765	420	3	F	Yes
		765	-	2	F	Yes
		560	210	2	F	Yes
		560	1730	1	F	Yes

TABLE A10 (cont')

SUMMARY OF DATA COLLECTED FROM INTERVIEW SURVEY

Bus Route	Bus Stop Location	Walking Distance from home to Bus Stop (ft)	Walking Distance from Bus Stop to Work(ft)	Waiting Time (min).	Sex M=Male F=Female	Knowledge of Bus Schedule
1	2	3	4	5	6	7
		700	210	2	M	Yes
		210	1520	1	F	Yes
		490	-	4	F	Yes
		560	-	1	F	Yes
		560	350	1	M	Yes
N7	1059	1530	-	15	M	Yes
		420	560	7	F	Yes
		280	700	1	M	Yes
		1040	830	3	M	Yes
		970	220	2	M	Yes
		900	840	2	M	Yes
		280	140	2	F	Yes
		1100	1740	1	F	Yes
		280	-	6	F	Yes
		900	-	6	F	Yes
		1320	-	2	M	Yes
		900	-	1	F	Yes
		1460	560	10	M	Yes
		700	-	8	F	Yes
		2080	630	2	M	Yes
		1460	840	1	F	Yes
		210	420	2	F	Yes
		280	280	6	F	Yes
		350	420	5	F	Yes
		420	-	3	F	Yes
		900	700	2	F	Yes
		2080	700	2	F	Yes
N7	2045	1530	280	3	F	Yes
		1110	280	3	F	Yes
		630	-	0	F	Yes

TABLE A10 (cont')

SUMMARY OF DATA COLLECTED FROM INTERVIEW SURVEY

Bus Route	Bus Stop Location	Walking Distance from home to Bus Stop (ft)	Walking Distance from Bus Stop to Work(ft)	Waiting Time (min).	Sex M=Male F=Female	Knowledge of Bus Schedule
1	2	3	4	5	6	7
N8	7313	830	-	-	F	Yes
		770	-	-	F	Yes
		700	-	-	F	Yes
		1670	-	-	F	Yes
		280	-	-	F	Yes
N8	7315	490	900	6	M	Yes
		1100	-	9	M	Yes
		840	2200	3	M	Yes
		280	-	1	M	Yes
		-	-	0	M	-
		700	-	8	F	Yes
		700	280	8	M	Yes
		140	-	6	F	Yes
		1950	240	4	M	Yes
		910	1400	3	M	Yes
		1180	140	7	F	Yes
N9	8402	-	-	2	F	Yes
		3060	-	0	M	No
		3060	700	12	F	Yes
		-	-	9	F	No
		1600	210	8	F	Yes
		2780	-	2	M	Yes
		-	-	8	F	Yes
		560	-	5	F	Yes
		4500	700	2	F	Yes
		4500	840	2	F	Yes
		-	-	0	F	Yes
		-	-	3	F	Yes
N9	8609	1040	280	4	F	Yes
		-	-	3	M	Yes
		560	840	3	F	Yes
		-	-	0	M	-

TABLE A10 (cont')

SUMMARY OF DATA COLLECTED FROM INTERVIEW SURVEY

Bus Route	Bus Stop Location	Walking Distance from home to Bus Stop (ft)	Walking Distance from Bus Stop to Work(ft)	Waiting Time (min).	Sex M=Male F=Female	Knowledge of Bus Schedule
1	2	3	4	5	6	7
		770	700	3	M	Yes
		350	140	2	M	Yes
		140	2200	8	F	Yes
		3200	840	3	F	Yes
		770	700	#	F	Yes
		420	210	3	F	Yes
		420	-	2	F	Yes
		490	210	2	F	No
		560	840	1	F	Yes
		560	280	1	F	Yes
		-	-	0	M	Yes
		350	-	1	F	Yes
		490	-	3	F	Yes
		140	1050	3	F	Yes
		770	420	2	M	No
		-	-	0	M	-
		-	-	0	F	-
		1110	-	2	F	Yes
N10	5228	770	-	2	M	Yes
		1040	560	3	M	Yes
		1040	280	3	F	Yes
		760	140	3	F	Yes
		560	970	2	M	Yes
		210	280	2	M	Yes
		-	-	0	F	-
		-	-	0	M	-
		210	280	6	M	Yes
		770	210	2	M	Yes
		1180	210	0	F	Yes
		1950	140	4	F	Yes
		1040	1460	2	F	Yes
		970	-	6	F	Yes
		700	280	5	M	Yes

TABLE A10 (cont')

SUMMARY OF DATA COLLECTED FROM INTERVIEW SURVEY

Bus Route	Bus Stop Location	Walking Distance from home to Bus Stop (ft)	Walking Distance from Bus Stop to Work(ft)	Waiting Time (min).	Sex M=Male F=Female	Knowledge of Bus Schedule
1	2	3	4	5	6	7
N10	7225	1250	560	5	F	Yes
		210	280	5	M	Yes
		700	140	6	F	Yes
		830	210	3	M	Yes
		490	2640	2	F	Yes
		6100	210	0	M	Yes
		490	140	9	F	Yes
		700	280	9	F	Yes
		140	280	4	F	Yes
		2200	-	3	F	Yes
		4800	560	1	M	Yes
		4800	210	1	F	Yes
		420	-	14	M	Yes
		1100	-	14	M	Yes
		280	-	7	F	Yes
		700	140	5	M	Yes
		700	140	3	F	Yes
		250	140	2	F	Yes
		840	140	1	M	Yes
N11	6213	-	-	0	M	-
		-	-	1	F	Yes
		-	-	0	F	Yes
		-	-	0	M	Yes
		630	140	16	F	Yes
		1530	210	16	F	Yes
		-	-	16	M	Yes
		-	-	9	F	Yes
		1530	210	3	F	Yes
		-	-	5	F	Yes
		1530	140	4	F	Yes
		-	-	3	M	Yes
		280	1040	2	M	Yes
		1530	1670	2	M	Yes
		-	-	9	F	Yes
		970	210	8	F	Yes
		560	420	5	F	Yes

TABLE A10 (cont')

SUMMARY OF DATA COLLECTED FROM INTERVIEW SURVEY

Bus Route	Bus Stop Location	Walking Distance from home to Bus Stop (ft)	Walking Distance from Bus Stop to Work(ft)	Waiting Time (min).	Sex M=Male F=Female	Knowledge of Bus Schedule
1	2	3	4	5	6	7
		1320	70	1	F	Yes
		216	140	3	F	Yes
		-	-	2	F	Yes
		-	-	2	M	Yes
N11	6214	970	-	3	F	Yes
		970	-	5	F	Yes
		350	-	5	M	Yes
		830	560	5	F	Yes
		970	280	5	F	Yes
		350	-	5	F	Yes
		700	700	0	M	Yes
		70	-	0	F	Yes
		1320	-	8	M	Yes
		420	1050	3	M	Yes
		1250	350	2	M	Yes
		-	-	0	F	Yes
		1390	-	9	F	Yes
		700	-	8	M	Yes
		420	-	5	M	Yes
		1050	1530	4	F	Yes
		70	-	4	F	Yes
		70	-	4	-	Yes
		70	280	4	F	Yes
		830	1390	4	F	Yes
		1390	140	4	M	Yes
		420	-	5	M	Yes
		140	280	2	F	Yes
		70	-	8	M	Yes
N12	9419	3700	1180	5	M	Yes
		-	-	4	F	Yes

TABLE A10 (cont')

SUMMARY OF DATA COLLECTED FROM INTERVIEW SURVEY

Bus Route	Bus Stop Location	Walking Distance from home to Bus Stop (ft)	Walking Distance from Bus Stop to Work(ft)	Waiting Time (min).	Sex M=Male F=Female	Knowledge of Bus Schedule
1	2	3	4	5	6	7
N12	10412	280	2100	1	M	Yes
		700	1050	6	F	Yes
		350	900	4	M	Yes
		416	-	10	M	Yes
		700	-	8	M	Yes
		700	210	4	F	Yes
		350	-	3	F	Yes
N12	10413	280	-	5	F	Yes

Explanations of Table A10

Column 1 - Bus route on which bus stop is located.

" 2 - Bus stop location; to be interpreted as explained in "Explanation of Table A6 - Column 2".

" 3 - Walking distance from home to bus stop. It is determined by scaling from a 1" = 1400 feet map, the distance between the home address and the particular bus stop location.

" 4 - Walking distance from the bus stop closest to where the person works, taking into account bus route used to arrive at the C.B.D. and the possibility of transfers in the C.B.D.

" 5 - Waiting time, which is the time from when the person arrived at the bus stop to when the bus arrived.

" 6 - Sex of person interviewed.

" 7 - This question was asked to find out whether the person catching the bus had an approximate idea of when the bus would arrive.

TABLE A11

AVERAGE BUS TRAVEL TIME FROM REFERENCE C.B.D. DESTINATION TO C.B.D. DESTINATION ZONES (MIN.)

Bus Route	C.B.D. Refer' Destination		C.B.D. Destination Zones			
	St	Av	0010	0020	0040	0060
N4	102	Jasper	-3.06	+3.96	6.92	10.85
N5	102	Jasper	-3.06	3.96	6.92	10.85
N6	101	Jasper	0	1.95	9.34	13.85
N7	101	Jasper	0	1.95	9.34	13.85
N8	101	Jasper	transfers to N9			
N9	101	Jasper	0.69	3.19	4.80	8.08
N10	102	Jasper	-3.06	3.96	6.92	10.85
N11	102	Jasper	-3.06	3.96	6.92	10.85
N12	101	Jasper	transfers to N9			
N13	101	Jasper	transfers to N9			
R3	101	Jasper	transfers to N9			
R4	102	Jasper	transfers to N4			

TABLE A12

AVERAGE SPEED ON EXISTING BUS ROUTES

NORTH OF 127TH AVENUE

Bus Route	Timed Section on Bus Route From	To	Time on this Section T (min)	Distance on this Section D(miles)	Average (MPH) Speed on Bus Route S = D/T
N4	5148	5107	23.63	4.92	12.5
N5	5125	5107	19.09	4.16	13.0
N6	1008	1031	16.62	3.96	14.3
N7	2007	1031	18.45	4.10	13.3
N8	7306	6318	12.90	2.44	11.3
N9	8402	8610	7.64	2.06	16.1
N10	6221	5146	13.00	2.40	11.0
N11	5202	5146	14.80	2.92	11.76
N12	10411	6401	10.87	2.80	15.36
N13	9504	6401	11.27	3.38	18.00

TABLE A13

BUS TIMES FOR PROPOSED BUS ROUTE (P) FROM

REFERENCE DESTINATION NUMBER 2

Bus Route	Reference Destination Number 2		Reference C.B.D. Destination		Time from Reference Dest.No.2 to Ref. CBD. Dest.	Time Adjustment for each C.B.D. Dest. Zone. (min) from CBD Ref. Dest. No.2			
	St	Av	St	Av		0010	0020	0040	0060
(a)1	2	3	4	5	6	7	8	9	10
P1	124	118	101	Jasper	15 min.	0	1.95	9.34	13.85
P2	124	118	101	Jasper	15 min.	0	1.95	9.34	13.85
P3	97	118	102	Jasper	15 min.	-3.06	3.96	6.92	10.85
P4	97	118	102	Jasper	15 min.	-3.06	3.96	6.92	10.85
P5	82	118	101	Jasper	15 min.	0.69	3.19	4.80	8.08
P6	82	118	101	Jasper	15 min.	0.69	3.19	4.80	8.08
P7	66	127	101	Jasper	24 min.	0.69	3.19	4.80	8.08
P8	66	127	101	Jasper	24 min.	0.69	3.19	4.80	8.08
P9	66	127	101	Jasper	23 min.	0.69	3.19	4.80	8.08
P10	66	127	101	Jasper	23 min.	0.69	3.19	4.80	8.08

(a) See explanation of table page A40

Explanation of Table A13

Column 1	-	Proposed bus route designation number (APPENDIX E).
" 2-3	-	Reference Destination Number 2 has similar meaning to Reference Destination Number 1 (see definition pageA19), except here, bus passes this location only once and that is when it is bound directly for the C.B.D.
" 4-5	-	Reference C.B.D. destination (see definition on pageA19).
" 6	-	Time between Reference Destination Number 1 to Reference C.B.D. Destination.
" 7,8,9,10	-	These are time adjustments, from Reference C.B.D. Destination, that are necessary to find the time from each origin zone to each destination zone (see TABLE A11).

TABLE A14

AVERAGE TIME FROM ORIGIN ZONES TO REFERENCE

DESTINATION NUMBER 2

Bus Route	Origin Zone	Average Dist. of Origin Zone from Ref.Dest. No.2 (miles)	Average Speed (M.P.H.)	Average Time from Origin Zone to Ref. Dest. No. 2.
1	2	3	4	5
P1	1310	2.74	13.8	11.4 min.
P2	1320	2.02	12.7	9.0 min.
	1330	2.62	12.7	12.0 min.
	1340	3.27	12.7	15.4 min.
P3	1320	3.10	12.7	14.6 min.
	1330	2.50	12.7	11.0 min.
	1340	1.85	12.7	8.7 min.
	1410.	1.28	12.7	6.0 min.
P4	1410	1.52	11.4	8.0 min.
	1431	2.30	11.4	12.1 min.
	1421	2.80	11.4	14.7 min.
P5	1421	1.26	11.4	6.6 min.
	1431	1.78	11.4	9.4 min.
	1410	2.56	11.4	13.5 min.
P6	1431	2.02	11.3	10.7 min.
	1421	1.26	11.3	6.7 min.
P7	1421	2.04	11.3	10.8 min.
P8	1440	0.88	16.1	3.3 min.
P9	1920	1.96	18.0	6.5 min.
	1431	0.76	18.0	2.5 min.
	1421	0.26	18.0	0.9 min.
P10	1930	1.96	18.0	6.5 min.
	1431	0.76	18.0	2.5 min.
	1421	0.26	18.0	0.9 min.

TABLE A15

BUS RUNNING TIMES FROM EACH ORIGIN ZONE TO EACH

DESTINATION ZONE FOR PROPOSED BUS ROUTE "P"

Origin Zone	Destination Zone			
	"0010"	"0020"	"0040"	"0060"
1[(a)]	2	3	4	5
1310	26.4	28.4	35.7	40.3
1320	25.3	29.8	34.9	39.2
1330	25.0	29.5	34.6	33.9
1340	25.5	30.0	35.2	39.4
1410	22.4	27.9	30.4	34.1
1421	26.0	29.3	31.1	34.5
1431	25.6	29.0	30.9	34.3
1440	28.0	30.5	32.1	35.4
1920	30.2	32.7	34.3	37.6
1930	30.2	32.7	34.3	37.6

(a) See explanation for Table page A43

Explanation of Table A15

Column	1	-	Origin Zone
"	2,3,4,5	-	Bus running times from each origin zone to each destination zone in the C.B.D. The following calculation is an example of how the time was derived between zone "1320" and "0010".

Time for bus route P2 =

9.0 (Table A14,Col.5) + 15 (Table A13,Col.6) +0 (Table A13,Col.7) = 24.0.

Time for bus route P3 =

14.6 (Table A14,Col.5) + 15 (Table A13,Col.6) +(-3.06)(Table A13,Col.7) = 26.54.

The average time from each bus route is therefore

$(24.0 + 26.54) \div 2 = 25.3$

This illustrates that if there is more than <u>one</u> time calculated for any two origin-destination zone combination, then the average of the times is used.

TABLE A16

BUS RUNNING TIMES FROM EACH ORIGIN ZONE TO EACH

DESTINATION ZONE FOR PROPOSED BUS ROUTE "EP"

Origin Zone	Destination Zone			
Zone	"0010"	"0020"	"0040"	"0060"
1[(a)]	2	3	4	5
1310	30.4	32.3	39.7	44.2
1320	29.3	33.4	38.9	43.2
1330	28.3	34.1	38.1	39.7
1340	27.7	33.4	37.5	41.6
1410	27.1	33.2	35.9	39.6
1421	28.6	33.1	35.3	38.8
1431	29.9	33.9	35.0	39.4
1440	19.6	22.1	23.7	27.0
1920	43.6	46.1	47.1	51.0
1930	34.2	36.7	38.3	41.6

(a) See explanation for Table page A45

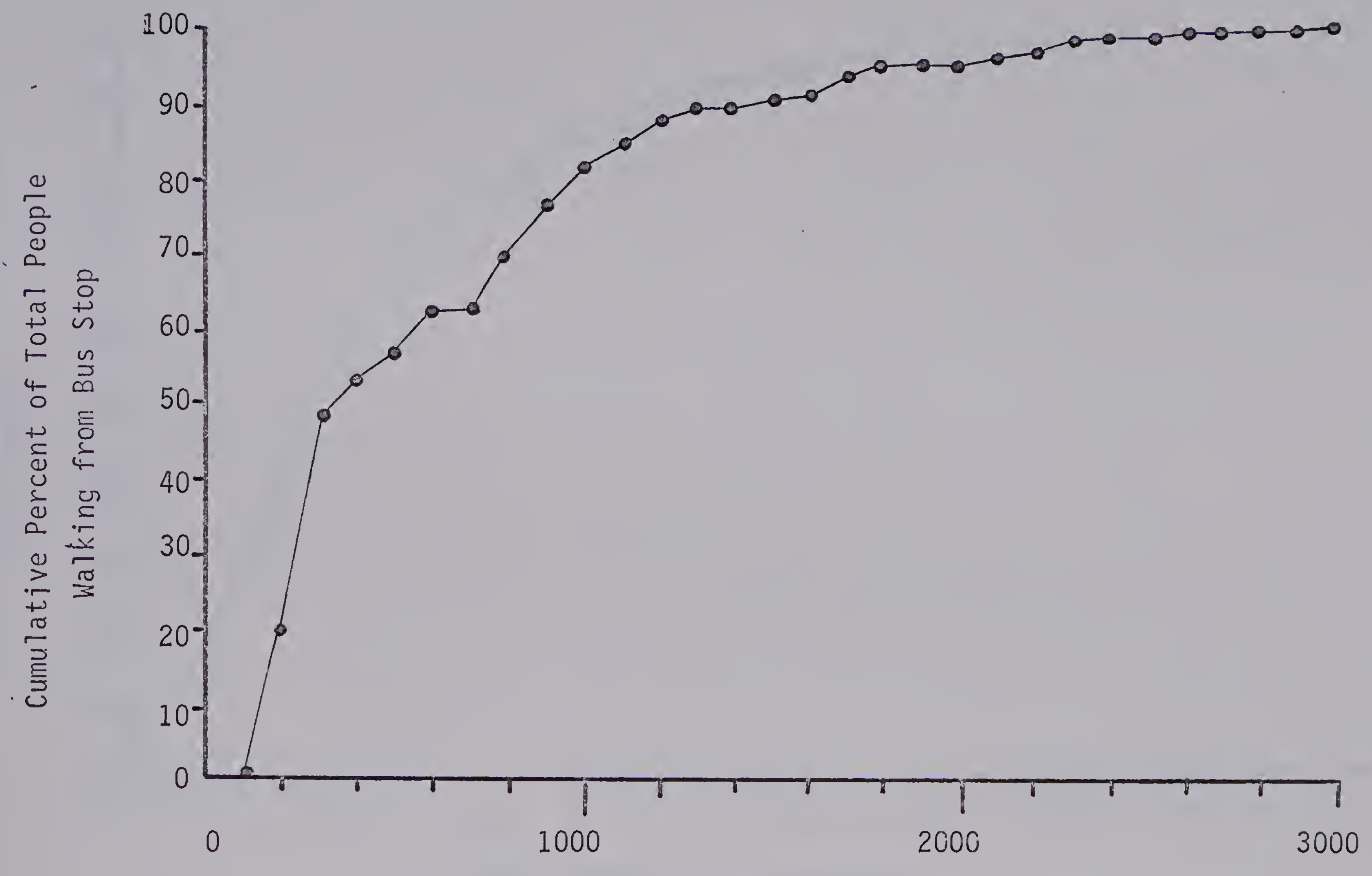
Explanation of Table A16

Column	1 -	Origin Zone
"	2,3,4,5 -	The bus times from bus routes "E" and "P" are here combined for bus route "EP". For a list of bus routes used here see TABLE D3 which shows that all the existing bus routes are used and 6 (six) of the proposed bus routes.
		For those zones which contain a combination of bus routes, - the average of the times is used. As an example, consider the bus time from origin zone "1330" to destination zone "0040".
		The time for existing bus route E = 41.66 (see APPENDIX A, TABLE A9).
		The time for proposed bus route P = 34.60 (see APPENDIX A, TABLE A15).
		Average = 38.1.

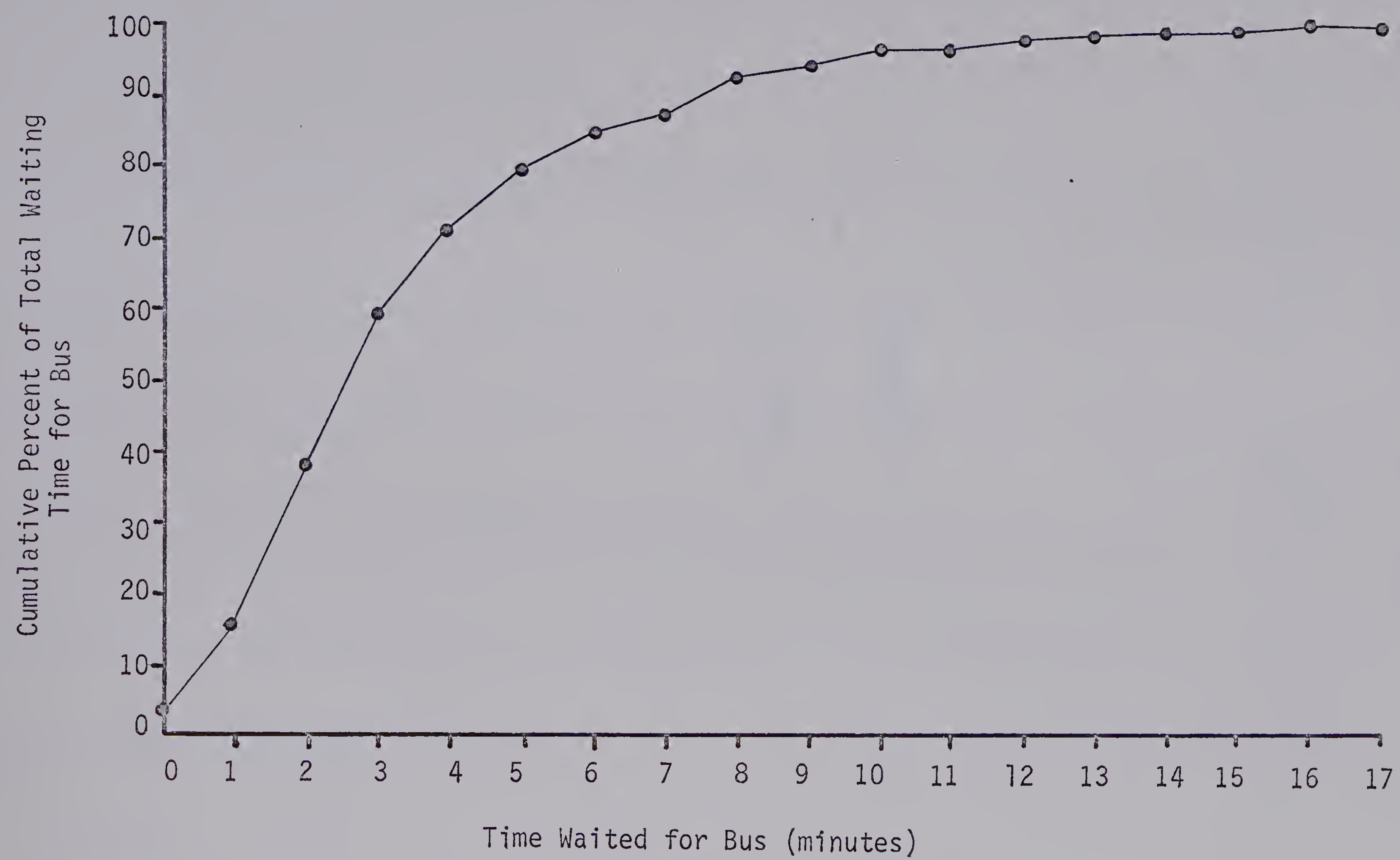
TABLE A17

PERCENT MALES AND FEMALES CATCHING BUS AND KNOWLEDGE OF BUS SCHEDULE, FROM INTERVIEW SURVEY

Percentage of females catching bus	=	60%
Percentage of males catching bus	=	40%
Percentage of females who know timetable	=	98%
Percentage of males who know timetable	=	98%
Percentage of all people who know timetable	=	98%



DISTANCE PEOPLE WALK FROM BUS STOP. FIGURE A1



TIME PEOPLE WAITED FOR BUS FIGURE A2

APPENDIX B

CAR TIMES

TABLE B1

CAR TRAVEL AND EXCESS TIMES

Origin Zone	Excess Time (min)	Destination Zones 0010 Travel	0010 Total	0020 Travel	0020 Total	0040 Travel	0040 Total	0060 Travel	0060 Total
1[a]	2	3	4	5	6	7	8	9	10
0210	4	3.9	7.9	2.8	6.8	3.3	7.3	5.7	9.7
0220	4	6.0	10.0	6.4	10.4	5.3	9.3	7.7	11.7
0230	4	5.5	9.5	4.4	8.4	3.3	7.3	5.7	9.7
0240	4	6.2	10.2	5.1	9.1	4.0	8.0	6.1	10.0
0250	4	7.8	11.8	6.7	10.7	5.6	9.6	7.7	11.7
0260	4	8.3	12.3	9.1	13.1	8.6	12.6	11.0	15.0
0340	4	6.4	10.4	5.3	9.3	4.2	8.2	5.1	9.1
0430	4	8.5	12.5	9.3	13.3	10.8	14.8	13.2	17.2
0440	4	9.1	13.1	9.9	13.9	11.4	15.4	13.8	17.8
0510	4	5.6	9.6	6.4	10.4	7.1	11.1	9.5	13.5
0520	4	7.2	11.2	8.0	12.0	8.9	12.9	11.3	15.3
0540	4	10.1	14.1	10.9	14.9	12.4	16.4	14.8	18.8
0550	4	9.3	13.3	10.1	14.1	11.5	15.5	13.9	17.9
0560	4	7.9	11.9	8.7	12.7	9.3	13.3	11.7	15.7
0710	4	10.3	14.3	9.2	13.2	8.1	12.1	10.2	14.2
0720	4	8.8	12.8	7.7	11.7	6.6	10.6	8.7	12.7
0730	4	7.1	11.1	6.0	10.0	4.9	8.9	7.0	11.0
0810	4	12.5	16.5	11.4	15.4	10.3	14.3	12.4	16.4
0820	4	13.0	17.0	11.9	15.9	10.8	14.8	12.9	16.9
0830	4	11.2	15.2	10.1	14.1	9.0	13.0	11.1	15.1
0860	4	8.9	12.9	7.8	11.8	6.7	10.7	8.8	12.8
0870	4	10.1	14.1	9.0	13.0	7.9	11.9	10.0	14.0
0880	4	9.9	13.9	8.8	12.8	7.7	11.7	9.8	13.8
1150	4	13.9	17.9	12.8	16.8	11.7	15.7	13.8	17.8
1160	4	11.9	15.9	10.8	14.8	9.7	13.7	11.8	15.8
1170	4	13.8	17.8	12.7	16.7	11.6	15.6	13.7	17.7
1310	4	17.5	21.5	16.6	20.6	15.5	19.5	17.6	21.6
1320	4	15.6	19.6	15.9	19.9	14.8	18.8	16.9	20.9
1330	4	14.3	18.3	15.1	19.1	15.7	19.7	18.1	22.1
1340	4	12.6	16.6	13.4	17.4	13.4	17.4	16.4	20.4
1410	4	11.9	15.9	12.7	16.7	13.3	17.3	15.7	19.7
1421	4	12.7	16.7	13.5	17.5	14.1	18.1	16.5	20.5
1431	4	14.1	18.1	14.9	18.9	15.5	19.5	17.9	21.9
1440	4	14.8	18.8	15.6	19.6	17.1	21.1	19.5	23.5
1520	4	11.7	15.7	12.5	16.5	14.0	18.0	16.4	20.4
1620	4	12.8	16.8	13.6	17.6	15.1	19.1	17.5	21.5
1630	4	12.0	16.0	12.8	16.8	14.3	18.3	16.7	20.7
1920	4	15.9	19.9	16.7	20.7	17.3	21.3	19.7	23.7
1930	4	16.3	20.3	17.1	21.1	18.6	22.6	21.0	25.0
1940	4	17.1	21.1	17.9	21.9	19.4	23.4	21.8	25.8

(a) See explanation of table page B3

Explanation of Table B1

Column	1	-	Zone from which trip originated.
"	2	-	Excess car time, see discussion Chapter - Data Collection.
"	3,5,7,9	-	Travel time only from each origin zone to each C.B.D. destination zone.
"	4,6,8,10	-	Total travel time - the sum of travel time and excess time.

APPENDIX C

TRAVEL TIME FACTORS FOR MODE SPLIT EQUATIONS

TABLE C1

SUMMARY OF TRAFFIC ZONE DATA FOR EXISTING

BUS ROUTE NETWORK TO DESTINATION ZONE 0010,

CALCULATED USING THE MINIMUM PATH METHOD

Zone	Actual Mode Split %	Ratio: Bus Time / Car Time	Difference Bus Time -Car Time (minutes)	Bus Running Time Only (minutes)	Excess Bus Time (minutes)	Total Bus Travel Time (minutes)
Range of House Sale Values: $13,000						
0260	50	2.0	12.9	15.4	9.8	25.2
0430	45	2.3	15.9	18.6	9.8	28.4
0510	60	2.5	14.2	15.2	8.6	23.8
0520	55	2.8	20.3	21.5	10.0	31.5
0540	33	2.4	19.4	21.1	12.4	33.5
0550	45	3.0	26.1	27.2	12.2	39.4
0560	47	2.2	13.9	15.7	10.1	25.8
0710	54	2.1	15.5	17.6	12.2	29.8
0720	57	2.3	16.6	19.4	10.0	29.4
1160	41	2.0	15.8	20.9	10.8	31.7
1520	25	2.3	20.1	25.0	10.8	35.8
Range of House Sale Values: $13,000 to $15,000						
0220	53	1.9	9.0	9.2	9.8	19.0
0230	57	2.2	11.5	9.3	11.7	21.0
0730	52	1.9	10.5	12.3	9.3	21.6
0820	33	2.3	22.2	26.8	12.4	39.2
0860	45	2.0	12.7	12.0	13.6	25.6
0880	30	2.4	19.1	20.6	12.4	33.0
1150	34	2.3	22.8	29.1	11.6	40.7
1170	36	2.0	16.9	24.9	9.8	34.7
1310	41	1.4	9.1	19.7	10.9	30.6
1320	35	1.6	12.4	21.6	10.4	32.0
1330	35	1.9	16.0	24.6	9.7	34.3
1340	39	2.0	16.0	21.1	11.5	32.6
1620	36	2.4	23.6	26.6	13.8	40.4
1630	55	2.0	15.5	22.8	8.7	31.5
Range of House Sale Values: $15,000						
0210	37	2.2	9.5	7.4	10.0	17.4
0240	48	2.2	12.4	12.1	10.5	22.6
0250	40	1.7	7.8	7.9	11.7	19.6
0340	48	1.8	8.0	10.1	8.3	18.4
0440	47	2.5	19.0	20.9	11.2	32.1

TABLE C1 (cont')

SUMMARY OF TRAFFIC ZONE DATA FOR EXISTING

BUS ROUTE NETWORK TO DESTINATION ZONE 0010,

CALCULATED USING THE MINIMUM PATH METHOD

Zone	Actual Mode Split %	Ratio : Bus Time / Car Time	Difference Bus Time -Car Time (minutes)	Bus Running Time Only (minutes)	Excess Bus Time (minutes)	Total Bus Travel Time (minutes)
0810	28	2.3	21.1	26.9	10.7	37.6
0830	27	2.4	21.0	23.6	12.6	36.2
0870	26	2.1	15.3	17.7	11.7	29.4
1410	32	1.8	12.8	16.7	12.0	28.7
1421	34	-	-	-	-	-
1431	41	-	-	-	-	-
1440	44	2.0	18.9	29.2	10.5	37.7
1930	11	-	-	-	-	-
1940	22	-	-	-	-	-

TABLE C2

SUMMARY OF TRAFFIC ZONE DATA FOR EXISTING

BUS ROUTE NETWORK TO DESTINATION ZONE 0020,

CALCULATED USING THE MINIMUM PATH METHOD

Zone	Actual Mode Split %	Ratio: Bus Time / Car Time	Difference Bus Time -Car Time (minutes)	Bus Running Time Only (minutes)	Excess Bus Time (minutes)	Total Bus Travel Time (minutes)
		Range of House Sale Values:		$13,000		
0260	63	1.9	11.4	15.4	9.1	24.5
0430	53	2.1	14.4	18.6	9.1	27.7
0510	71	2.2	12.7	15.2	7.9	23.1
0520	60	2.6	18.8	21.5	9.3	30.8
0540	46	2.2	17.9	21.1	11.7	32.8
0550	66	2.7	24.6	27.2	11.5	38.7
0560	47	2.0	12.4	15.7	9.5	25.1
0710	43	2.2	15.9	17.6	11.5	29.1
0720	58	2.5	17.0	19.4	9.3	28.7
1160	52	2.1	16.2	20.9	10.1	31.0
1520	30	2.1	18.6	25.0	10.1	35.1
		Range of House Sale Values:		$13,000 to $15,000		
0220	44	1.8	7.9	9.2	9.1	18.3
0230	48	2.4	11.9	9.3	11.0	20.3
0730	50	2.1	10.9	12.3	8.6	20.9
0820	29	2.4	22.6	26.8	11.7	38.5
0860	42	2.1	13.1	12.0	12.9	34.9
0880	34	2.5	19.5	20.6	11.7	32.3
1150	26	2.4	23.2	29.1	10.9	40.0
1170	31	2.0	17.3	24.9	9.1	34.0
1310	48	1.5	9.3	19.7	10.2	29.9
1320	54	1.6	11.4	21.6	9.7	31.3
1330	40	1.8	14.5	24.6	9.0	33.6
1340	36	1.8	14.5	21.1	10.8	31.9
1620	43	2.3	22.1	26.6	13.1	39.7
1630	52	1.9	14.0	22.8	8.0	30.8
		Range of House Sale Values:		$15,000		
0210	44	2.5	9.9	7.4	9.3	16.7
0240	46	2.4	12.8	12.1	9.8	21.9
0250	23	1.8	8.2	7.9	11.0	18.9
0340	40	1.9	8.4	10.1	7.6	17.7
0440	48	2.2	16.5	20.9	10.5	30.4
0810	34	2.4	21.5	26.9	10.0	36.9
0830	39	2.5	21.4	23.6	11.9	35.5

TABLE C2 (cont')

SUMMARY OF TRAFFIC ZONE DATA FOR EXISTING

BUS ROUTE NETWORK TO DESTINATION ZONE 0020,

CALCULATED USING THE MINIMUM PATH METHOD

Zone	Actual Mode Split %	Ratio: Bus Time / Car Time	Difference Bus Time -Car Time (minutes)	Bus Running Time Only (minutes)	Excess Bus Time (minutes)	Total Bus Travel Time (minutes)
0870	25	2.2	15.7	17.7	11.0	28.7
1410	44	1.7	11.3	16.7	11.3	28.0
1421	37	-	-	-	-	-
1431	50	-	-	-	-	-
1440	51	2.0	19.4	29.2	9.8	39.0
1930	18	-	-	-	-	-
1940	20	-	-	-	-	-

TABLE C3

SUMMARY OF TRAFFIC ZONE DATA FOR EXISTING BUS ROUTE NETWORK TO DESTINATION ZONE 0040, CALCULATED USING THE MINIMUM PATH METHOD

Zone	Actual Mode Split %	Ratio: Bus Time / Car Time	Difference Bus Time -Car Time (minutes)	Bus Running Time Only (minutes)	Excess Bus Time (minutes)	Total Bus Travel Time (minutes)
Range of House Sale Values: $13,000						
0260	17	2.6	20.4	21.1	11.9	33.0
0430	47	2.0	15.1	19.5	10.4	29.9
0510	55	2.3	14.7	17.3	8.5	25.8
0520	48	2.6	20.4	23.0	10.3	33.3
0540	41	2.1	18.6	20.9	14.1	35.0
0550	72	2.7	25.8	27.6	13.7	41.3
0560	37	2.6	21.4	21.9	12.8	34.7
0710	38	3.1	25.7	24.9	12.9	37.8
0720	49	2.4	15.3	15.2	10.7	25.9
1160	37	2.4	19.4	23.2	9.9	33.1
1520	12	2.2	21.7	25.9	13.8	39.7
Range of House Sale Values: $13,000 to $15,000						
0220	20	3.0	18.4	17.3	10.4	27.7
0230	30	4.1	22.5	17.5	12.3	29.8
0730	42	2.2	10.9	11.2	8.6	19.8
0820	25	2.4	21.3	22.6	13.5	36.1
0860	32	3.2	23.7	19.3	15.1	34.4
0880	25	2.8	21.6	19.6	13.7	33.3
1150	30	2.7	26.4	31.2	10.9	42.1
1170	16	2.3	20.5	27.2	8.9	36.1
1310	20	1.4	7.1	13.6	13.0	26.6
1320	32	1.5	9.2	15.5	12.5	28.0
1330	39	2.2	23.3	31.2	11.8	43.0
1340	22	2.4	23.8	27.6	13.6	41.2
1620	28	2.2	22.6	26.8	14.9	41.7
1630	39	1.8	14.5	23.0	9.8	32.8
Range of House Sale Values: $15,000						
0210	19	3.4	17.4	14.1	10.6	24.7
0240	14	3.8	22.4	19.3	11.1	30.4
0250	14	2.9	18.3	13.1	14.8	27.9
0340	52	1.9	7.0	5.6	9.6	15.2
0440	44	2.2	19.0	22.6	11.8	34.4

TABLE C3 (cont')

SUMMARY OF TRAFFIC ZONE DATA FOR EXISTING

BUS ROUTE NETWORK TO DESTINATION ZONE 0040,

CALCULATED USING THE MINIMUM PATH METHOD

Zone	Actual Mode Split %	Ratio: Bus Time / Car Time	Difference Bus Time -Car Time (minutes)	Bus Running Time Only (minutes)	Excess Bus Time (minutes)	Total Bus Travel Time (minutes)
0810	20	2.5	21.1	24.0	11.4	35.4
0830	13	2.7	21.5	20.8	13.7	34.5
0870	15	3.2	26.5	23.6	14.8	38.4
1410	17	2.2	20.0	23.2	14.1	37.3
1421	39	-	-	-	-	-
1431	18	-	-	-	-	-
1440	27	1.7	13.9	21.4	13.6	35.0
1930	23	-	-	-	-	-
1940	12	-	-	-	-	-

TABLE C4

SUMMARY OF TRAFFIC ZONE DATA FOR EXISTING

BUS ROUTE NETWORK TO DESTINATION ZONE 0060,

CALCULATED USING THE MINIMUM PATH METHOD

Zone	Actual Mode Split %	Ratio: Bus Time / Car Time	Difference Bus Time -Car Time (minutes)	Bus Running Time Only (minutes)	Excess Bus Time (minutes)	Total Bus Travel Time (minutes)
Range of House Sale Values: $13,000						
0260	34	2.6	23.3	24.4	13.9	38.3
0430	30	2.0	16.7	22.0	11.9	33.9
0510	40	2.2	16.6	18.4	11.7	30.1
0520	37	2.5	22.3	25.5	12.1	37.6
0540	41	2.1	20.5	25.2	14.1	39.3
0550	12	2.6	27.7	31.9	13.7	45.6
0560	21	2.5	23.3	27.4	11.6	39.0
071C	47	3.0	27.9	29.8	12.3	42.1
0720	45	2.1	14.5	17.1	10.1	27.2
1160	27	2.6	25.6	26.5	14.9	41.4
1520	8	2.2	23.5	28.1	15.8	43.9
Range of House Sale Values: $13,000 to $15,000						
0220	18	2.5	20.3	20.1	11.9	32.0
0230	25	3.5	24.4	20.3	13.8	34.1
0730	38	2.5	16.5	17.1	10.4	27.5
0820	19	2.6	27.5	29.9	14.5	44.4
0860	15	3.0	25.9	21.0	17.7	38.7
0880	21	3.0	27.8	24.9	16.7	41.6
1150	18	2.8	32.6	34.5	15.9	50.4
1170	16	2.5	26.7	30.5	13.9	44.4
1310	24	1.4	7.8	17.4	12.0	29.4
1320	45	1.5	9.9	19.3	11.5	30.8
1330	21	2.3	28.7	40.0	10.8	50.8
1340	28	2.4	28.6	36.4	12.6	49.0
1620	21	2.1	24.5	30.1	15.9	46.0
1630	23	1.8	16.4	26.3	10.8	37.1
Range of House Sale Values: $15,000						
0210	20	3.0	19.3	16.9	12.1	29.0
0240	25	3.5	24.7	23.1	11.6	34.7
0250	20	2.7	20.5	19.4	12.8	32.2
0340	34	1.8	7.4	6.1	10.4	16.5
0440	31	2.2	20.9	26.4	12.3	38.7
0810	16	2.7	27.3	30.9	12.8	43.7

TABLE C4 (cont')

SUMMARY OF TRAFFIC ZONE DATA FOR EXISTING

BUS ROUTE NETWORK TO DESTINATION ZONE 0060,

CALCULATED USING THE MINIMUM PATH METHOD

Zone	Actual Mode Split %	Ratio: Bus Time / Car Time	Difference Bus Time -Car Time (minutes)	Bus Running Time Only (minutes)	Excess Bus Time (minutes)	Total Bus Travel Time (minutes)
0830	15	2.8	27.7	28.1	14.7	42.4
0870	5	3.1	28.7	26.9	15.8	42.7
1410	6	2.3	25.4	32.0	13.1	45.1
1421	24	-	-	-	-	-
1431	29	-	-	-	-	-
1440	25	1.2	4.3	16.2	11.6	27.8
1930	0	-	-	-	-	-
1940	16	-	-	-	-	-

TABLE C5

SUMMARY OF TRAFFIC ZONE DATA FOR BUS ROUTE

NETWORK "E", CALCULATED USING THE FIELD METHOD

AND THE COMPLETE RANGE OF HOUSE SALE VALUES

Zone	Actual Mode Split %	House Sale Value $	Ratio: Bus Time / Car Time	Difference Bus Time -Car Time (minutes)	Bus Running Time Only (minutes)	Total Bus Travel Time (minutes)	Population Density Ratio
			Destination Zone "0010"				
1310	41	13,325	1.8	17.9	30.4	39.4	0.86
1320	35	14,914	2.2	22.8	33.4	42.4	0.82
1330	35	13,610	2.2	22.4	31.7	40.7	0.73
1340	29	14,810	2.3	22.2	29.8	38.8	0.72
1410	32	16,898	2.6	24.8	31.8	30.8	0.85
1421	34	16,901	2.5	24.3	31.2	40.2	0.84
1431	41	16,898	2.4	25.1	34.2	43.2	0.89
1440	44	15,274	1.5	9.8	19.6	28.6	0.86
1920	26	-	2.7	32.7	43.6	52.6	1.00
1930	11	15,516	2.1	22.9	34.2	43.2	1.00
			Destination Zone "0020"				
1310	41	13,325	2.0	20.7	32.3	41.3	0.86
1320	35	14.914	2.3	26.1	37.0	46.0	0.82
1330	35	13,610	2.5	28.6	38.7	47.7	0.73
1340	39	14,810	2.6	28.4	36.8	45.8	0.72
1410	32	16,898	2.9	31.1	38.5	47.5	0.85
1421	34	16,901	2.6	28.4	36.9	45.9	0.84
1431	41	16,898	2.5	28.9	38.8	47.8	0.89
1440	44	15,274	1.6	11.5	22.1	31.1	0.86
1920	26	-	2.7	34.4	46.1	55.1	1.00
1930	11	15,517	2.2	24.6	36.7	45.7	1.00
			Destination Zone "0040"				
1310	20	13,325	2.5	29.2	39.7	48.7	0.86
1320	32	14,914	2.8	33.1	42.9	51.9	0.82
1330	39	13,610	2.6	31.0	41.7	50.7	0.73
1340	22	14,810	2.8	31.4	39.8	48.8	0.72
1410	17	16,898	2.9	33.4	41.3	50.3	0.85
1421	39	16,901	2.7	30.2	39.5	48.5	0.84
1431	18	16,898	2.6	30.5	41.0	50.0	0.89
1440	27	15,274	1.6	11.6	23.7	32.7	0.86
1920	-	-	2.7	35.4	47.7	56.7	1.00
1930	23	15,516	2.1	24.7	38.3	47.3	1.00

TABLE C5 (cont')

SUMMARY OF TRAFFIC ZONE DATA FOR BUS ROUTE
NETWORK "E", CALCULATED USING THE FIELD METHOD
AND THE COMPLETE RANGE OF HOUSE SALE VALUES

Zone	Actual Mode Split %	House Sale Value $	Ratio: Bus Time / Car Time	Difference Bus Time -Car Time (minutes)	Bus Running Time Only (minutes)	Total Bus Travel Time (minutes)	Population Density Ratio
			Destination Zone "0060"				
1310	24	13,325	2.5	31.6	44.2	53.2	0.86
1320	45	14,914	2.7	35.3	47.2	56.2	0.82
1330	21	13,610	2.5	32.5	45.6	54.6	0.73
1340	28	14,810	2.5	32.3	43.7	52.7	0.72
1410	6	16,898	2.8	34.9	45.2	54.2	0.85
1421	24	16,901	2.5	31.4	43.2	52.2	0.84
1431	29	16,898	2.4	31.7	44.6	53.6	0.89
1440	25	15,274	1.5	12.5	27.0	36.0	0.86
1920	3	-	2.5	36.3	51.0	60.0	1.00
1930	0	15,516	2.0	25.6	41.6	50.6	1.00

TABLE C6

SUMMARY OF TRAFFIC ZONE DATA FOR BUS ROUTE

NETWORK "P", CALCULATED USING THE FIELD METHOD

AND THE COMPLETE RANGE OF HOUSE SALE VALUES

Zone	Actual Mode Split %	House Sale Value $	Ratio: Bus Time / Car Time	Difference Bus Time -Car Time (minutes)	Bus Running Time Only (minutes)	Total Bus Travel Time (minutes)	Population Density Ratio
Destination Zone "0010"							
1310		13,325	1.6	13.9	26.4	35.4	0.83
1320		14,915	1.8	14.7	25.3	34.3	0.67
1330		13,610	1.9	15.7	25.0	34.0	0.50
1340		14,810	2.1	17.9	25.5	34.5	0.45
1410		16,898	2.0	15.5	22.4	31.4	0.51
1421		16,901	2.1	18.3	26.0	35.0	0.58
1431		16,898	1.9	16.5	25.6	34.6	0.47
1440		15,274	2.0	18.2	28.0	37.0	0.68
1920		-	2.0	19.3	30.2	39.2	0.73
1930		15,516	1.9	18.9	30.2	39.2	0.89
Destination Zone "0020"							
1310		13,325	1.8	16.8	28.4	37.4	0.83
1320		14,914	1.9	18.9	29.8	38.8	0.67
1330		13,610	2.0	19.4	29.5	38.5	0.50
1340		14,810	2.2	21.6	30.0	39.0	0.45
1410		16,898	2.2	20.2	27.9	36.9	0.51
1421		16,901	2.2	20.8	29.3	38.3	0.58
1431		16,898	2.0	19.1	29.0	38.0	0.47
1440		15,274	2.0	19.9	30.5	39.5	0.68
1920		-	2.0	21.0	32.7	41.7	0.73
1930		15,517	1.9	20.6	32.7	41.7	0.89
Destination Zone "0040"							
1310		13,325	2.3	25.2	35.7	44.7	0.83
1320		14,914	2.3	25.1	34.9	43.9	0.67
1330		13,610	2.2	23.9	34.6	43.6	0.50
1340		14,810	2.5	26.8	35.2	44.2	0.45
1410		16,898	2.3	22.1	30.4	39.4	0.51
1421		16,901	2.2	22.0	31.1	40.1	0.58
1431		16,898	2.0	20.4	30.9	39.9	0.47
1440		15,274	1.9	20.0	32.1	41.1	0.68
1920		-	2.0	22.0	34.3	43.3	0.73
1930		15,516	1.9	20.7	34.3	43.3	0.89

TABLE C6 (cont')

SUMMARY OF TRAFFIC ZONE DATA FOR BUS ROUTE

NETWORK "P", CALCULATED USING THE FIELD METHOD

AND THE COMPLETE RANGE OF HOUSE SALE VALUES

Zone	Actual Mode Split %	House Sale Value $	Ratio: Bus Time / Car Time	Difference Bus Time -Car Time (minutes)	Bus Running Time Only (minutes)	Total Bus Travel Time (minutes)	Population Density Ratio
			Destination Zone "0060"				
1310		13,325	2.3	27.7	40.3	49.3	0.83
1320		14,914	2.3	27.3	49.2	48.2	0.67
1330		13,610	1.9	20.8	33.9	42.9	0.50
1340		14,810	2.4	28.0	39.4	48.4	0.45
1410		16,898	2.2	23.4	34.1	43.1	0.51
1421		16,901	2.1	23.0	34.5	43.5	0.58
1431		16,898	2.0	21.4	34.3	43.3	0.47
1440		15,274	1.9	20.9	35.4	44.4	0.68
1920		-	2.0	22.9	37.6	46.6	0.73
1930		15,516	1.9	21.6	37.6	46.6	0.89

TABLE C7

SUMMARY OF TRAFFIC ZONE DATA FOR BUS ROUTE

NETWORK "EP", CALCULATED USING THE FIELD METHOD

AND THE COMPLETE RANGE OF HOUSE SALE VALUES

Zone	Actual Mode Split %	House Sale Value $	Ratio: Bus Time / Car Time	Difference Bus Time -Car Time (minutes)	Bus Running Time Only (minutes)	Total Bus Travel Time (minutes)	Population Density Ratio
Destination Zone "0010"							
1310		13,325	1.8	17.9	30.4	39.4	0.86
1320		14,915	2.0	18.7	29.3	38.3	0.96
1330		13,610	2.0	19.0	28.3	37.3	0.95
1340		14,810	2.2	20.1	27.7	36.7	0.98
1410		16,898	2.3	20.2	27.1	36.1	0.89
1421		16,901	2.3	21.3	28.6	37.6	0.84
1431		16,898	2.2	20.8	29.9	38.9	0.93
1440		15,274	1.5	9.8	19.6	28.6	0.86
1920		-	2.6	23.7	43.6	52.6	1.00
1930		15,516	2.1	22.9	34.2	43.2	1.00
Destination Zone "0020"							
1310		13,325	2.0	20.7	32.3	41.3	0.86
1320		14,915	2.1	22.5	33.4	42.4	0.96
1330		13,610	2.3	24.0	34.1	43.1	0.95
1340		14,810	2.4	25.0	33.4	42.4	0.98
1410		16,898	2.5	25.6	33.2	42.2	0.89
1421		16,901	2.4	24.6	33.1	42.1	0.84
1431		16,898	2.3	24.0	33.9	42.9	0.93
1440		15,274	1.6	11.5	22.1	31.1	0.86
1920		-	2.7	34.4	46.1	55.1	1.00
1930		15,516	1.7	15.6	36.7	45.7	1.00
Destination Zone "0040"							
1310		13,325	2.5	29.2	39.7	48.7	0.86
1320		14,915	2.5	29.1	38.9	47.9	0.96
1330		13,610	2.4	27.4	38.1	47.1	0.95
1340		14,810	2.7	29.1	37.5	46.5	0.98
1410		16,898	2.6	27.8	35.9	44.9	0.89
1421		16,901	2.4	26.1	35.3	44.3	0.84
1431		16,898	2.3	25.5	36.0	45.0	0.93
1440		15,274	1.6	11.6	23.7	32.7	0.86
1920		-	2.6	34.8	47.1	56.1	1.00
1930		15,516	2.1	24.7	38.3	47.3	1.00

TABLE C7 (cont')

SUMMARY OF TRAFFIC ZONE DATA FOR BUS ROUTE NETWORK "EP", CALCULATED USING THE FIELD METHOD AND THE COMPLETE RANGE OF HOUSE SALE VALUES

Zone	Actual Mode Split %	House Sale Value $	Ratio: Bus Time / Car Time	Difference Bus Time -Car Time (minutes)	Bus Running Time Only (minutes)	Total Bus Travel Time (minutes)	Population Density Ratio
Destination Zone "0060"							
1310		13,325	2.5	31.6	44.2	53.2	0.86
1320		14,915	2.5	31.3	43.2	52.2	0.96
1330		13,610	2.2	26.6	39.7	48.7	0.95
1340		14,810	2.5	30.2	41.6	50.6	0.98
1410		16,898	2.5	29.2	39.6	48.6	0.89
1421		16,901	2.3	27.2	38.8	47.8	0.84
1431		16,898	2.2	26.5	39.4	48.4	0.93
1440		15,274	1.5	12.5	27.0	36.0	0.86
1920		-	2.5	36.3	51.0	60.0	1.00
1930		15,516	2.0	24.6	41.6	49.6	1.00

APPENDIX D

MODE SPLIT EQUATIONS

TABLE D1

TABULATION OF THE PROGRAMS USED FOR

CALCULATING THE REGRESSION ANALYSIS

Program Number	Dest. Zone	House Sale Value \$1000	Method Used to Calculate Bus Times	Program Number	Dest. Zone	House Sale Value \$1000	Method Used to Calculate Bus Times
S1	0010	< 13	Min.Path	E1	0010	All	Field
S2	"	13-15	" "	E2	0020	"	"
S3	"	> 15	" "	E3	0040	"	"
S4	0020	< 13	" "	E4	0060	"	"
S5	"	13-15	" "				
S6	"	> 15	" "				
S7	0040	< 13	" "				
S8	"	13-15	" "				
S9	"	> 15	" "				
T1	0060	< 13	" "				
T2	"	13-15	" "				
T3	"	> 15	" "				
U1	0010	All	" "	V1	0010	> 13	Min.Path
U2	0020	"	" "	V2	0020	> 13	" "
U3	0040	"	" "	V3	0040	> 13	" "
U4	0060	"	" "	V4	0060	> 13	" "

MODE SPLIT V'S TRAVEL TIME DIFFERENCE

PROGRAM V1

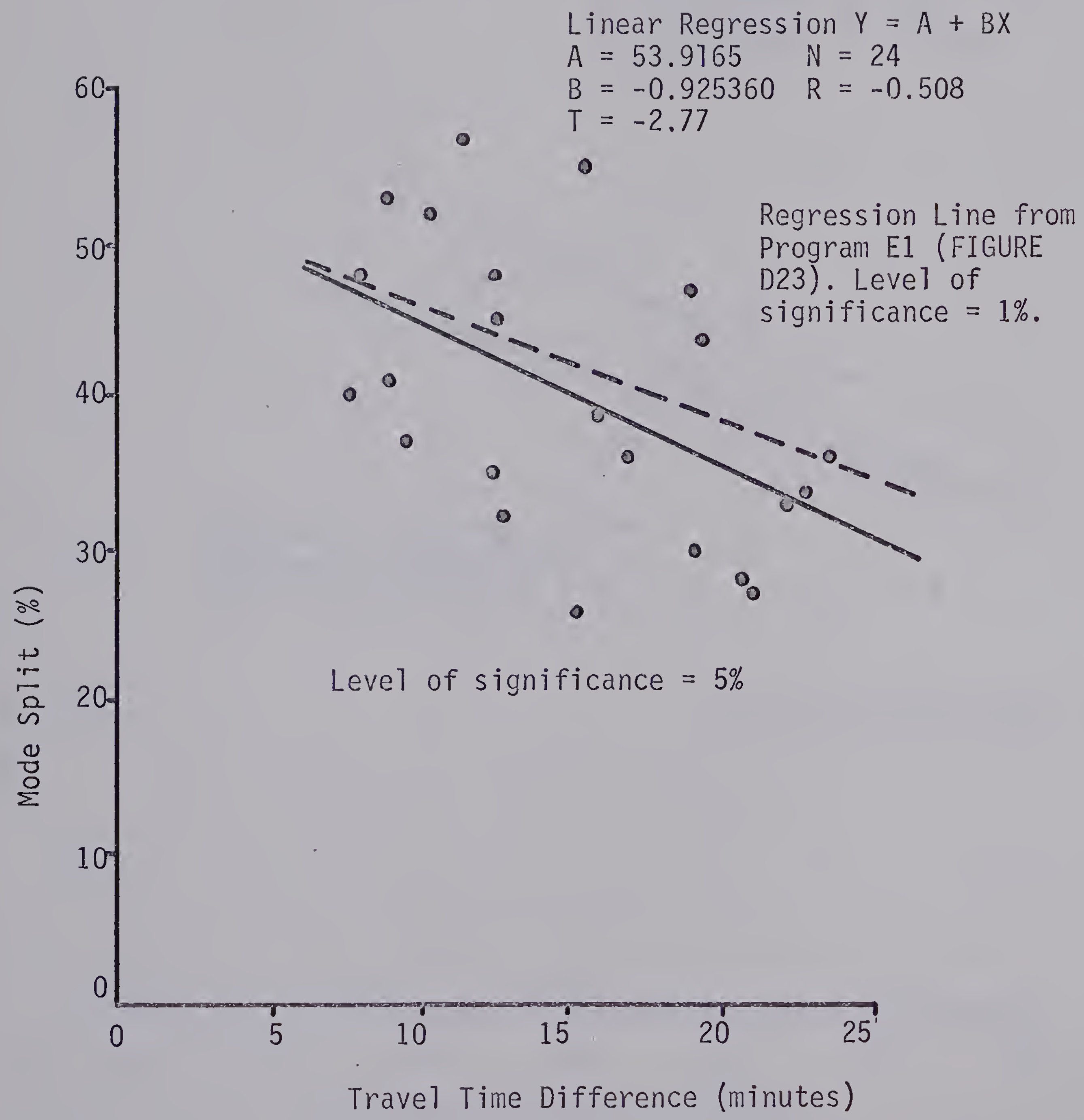


FIGURE D1

MODE SPLIT V'S BUS RUNNING TIME ONLY

PROGRAM V1

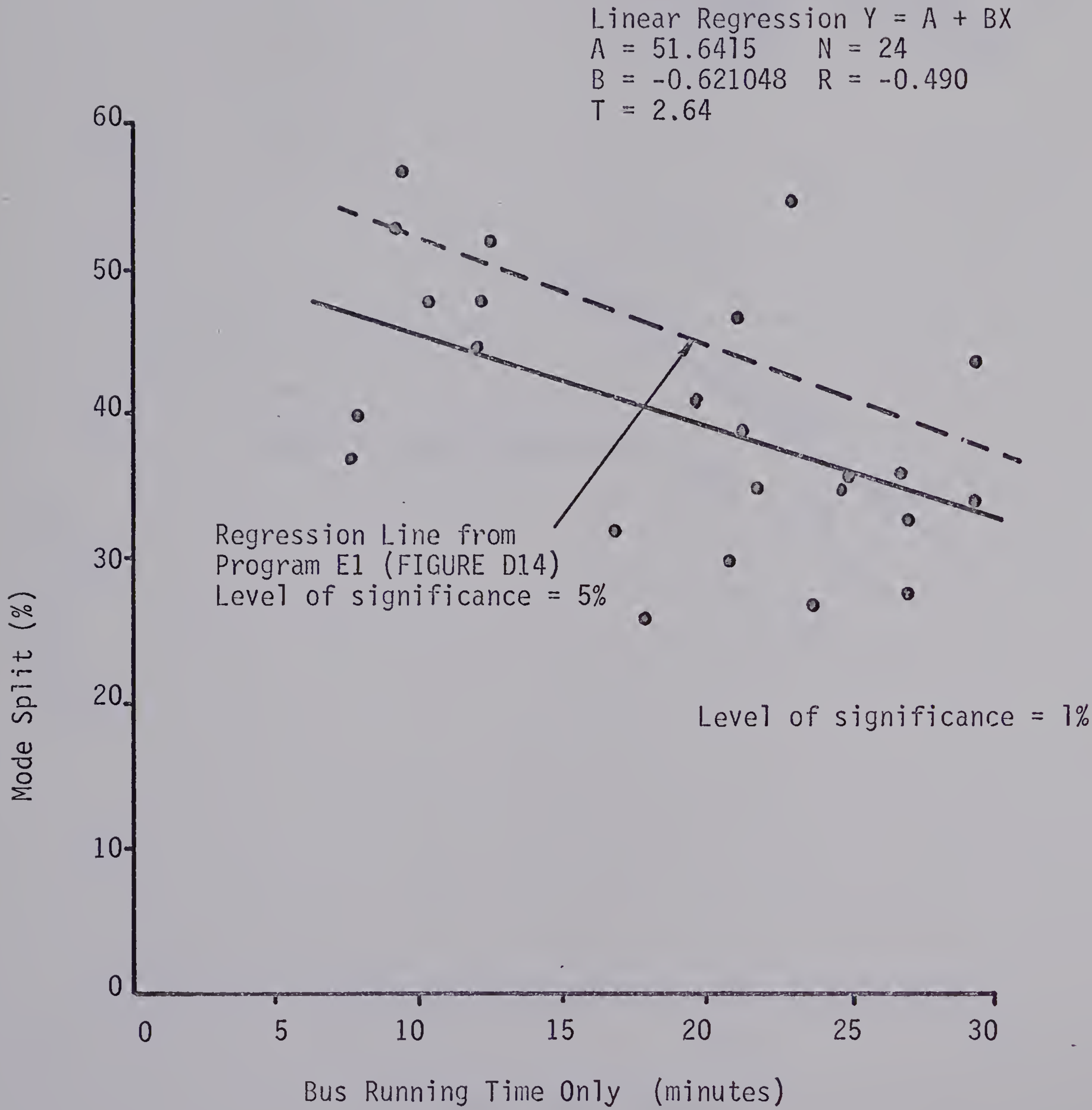


FIGURE D2

MODE SPLIT V'S BUS EXCESS TIME

PROGRAM V1

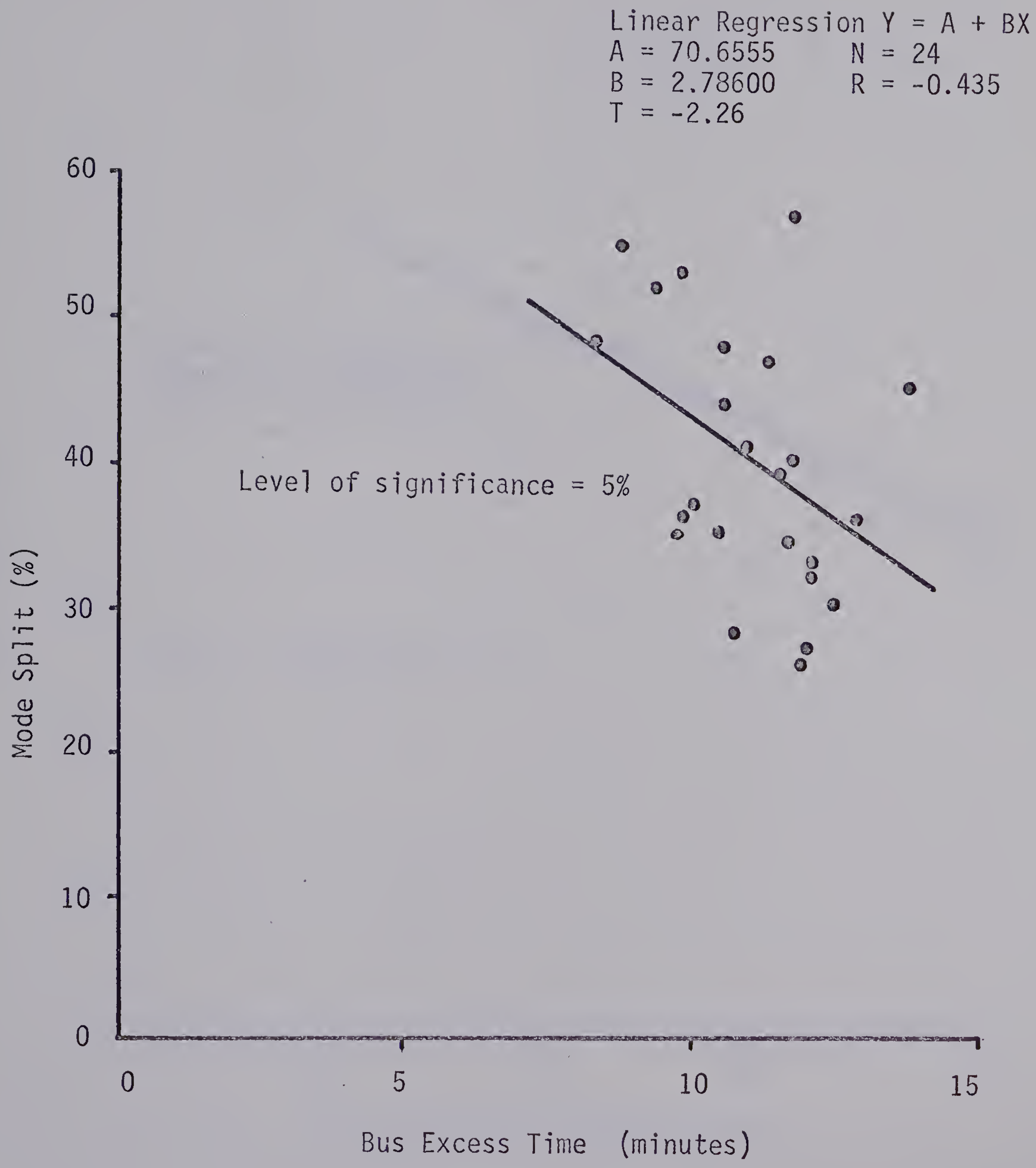


FIGURE D3

MODE SPLIT V'S TOTAL BUS TRAVEL TIME

PROGRAM V1

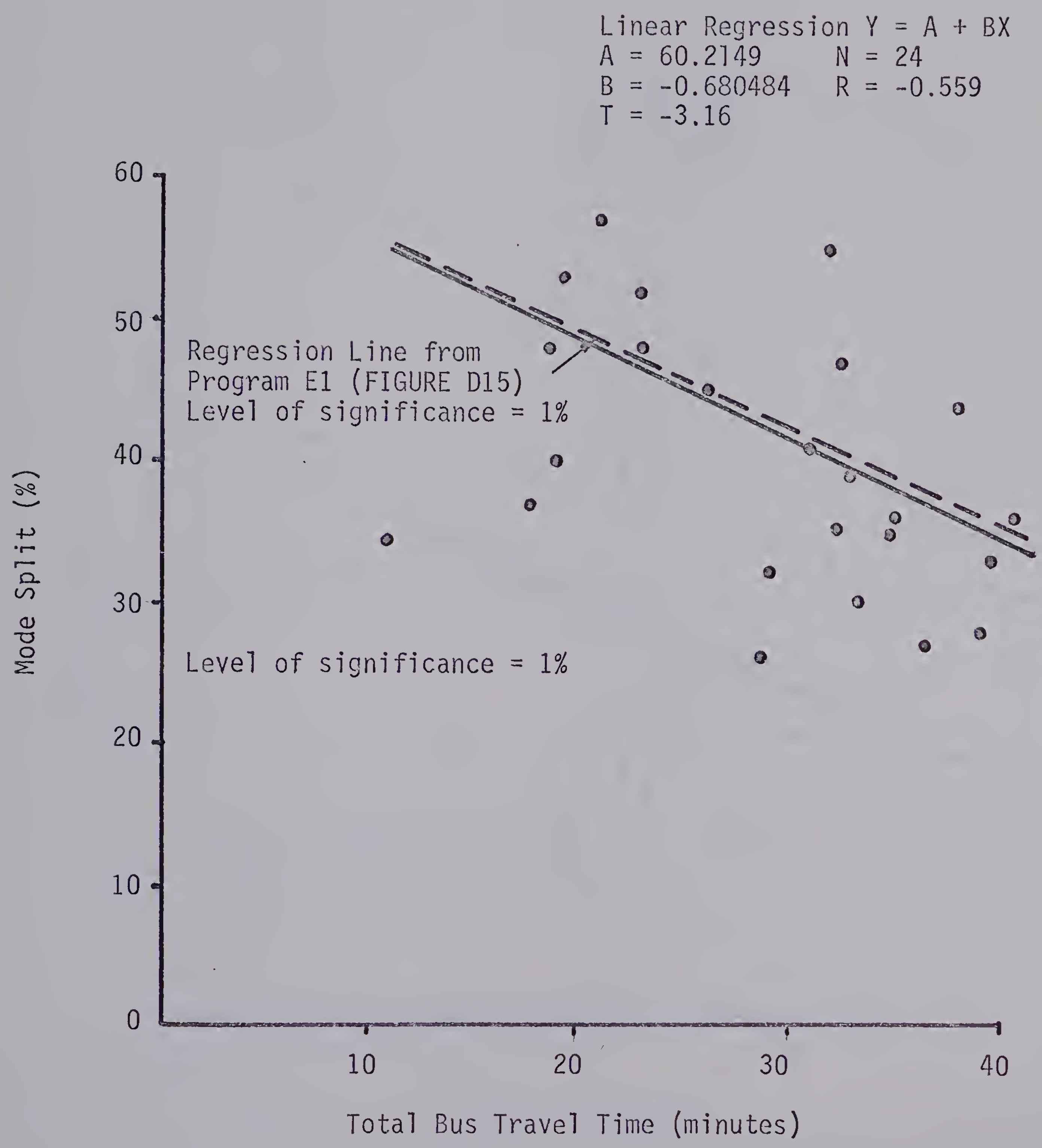


FIGURE D4

MODE SPLIT V'S TRAVEL TIME RATIO

PROGRAM V3

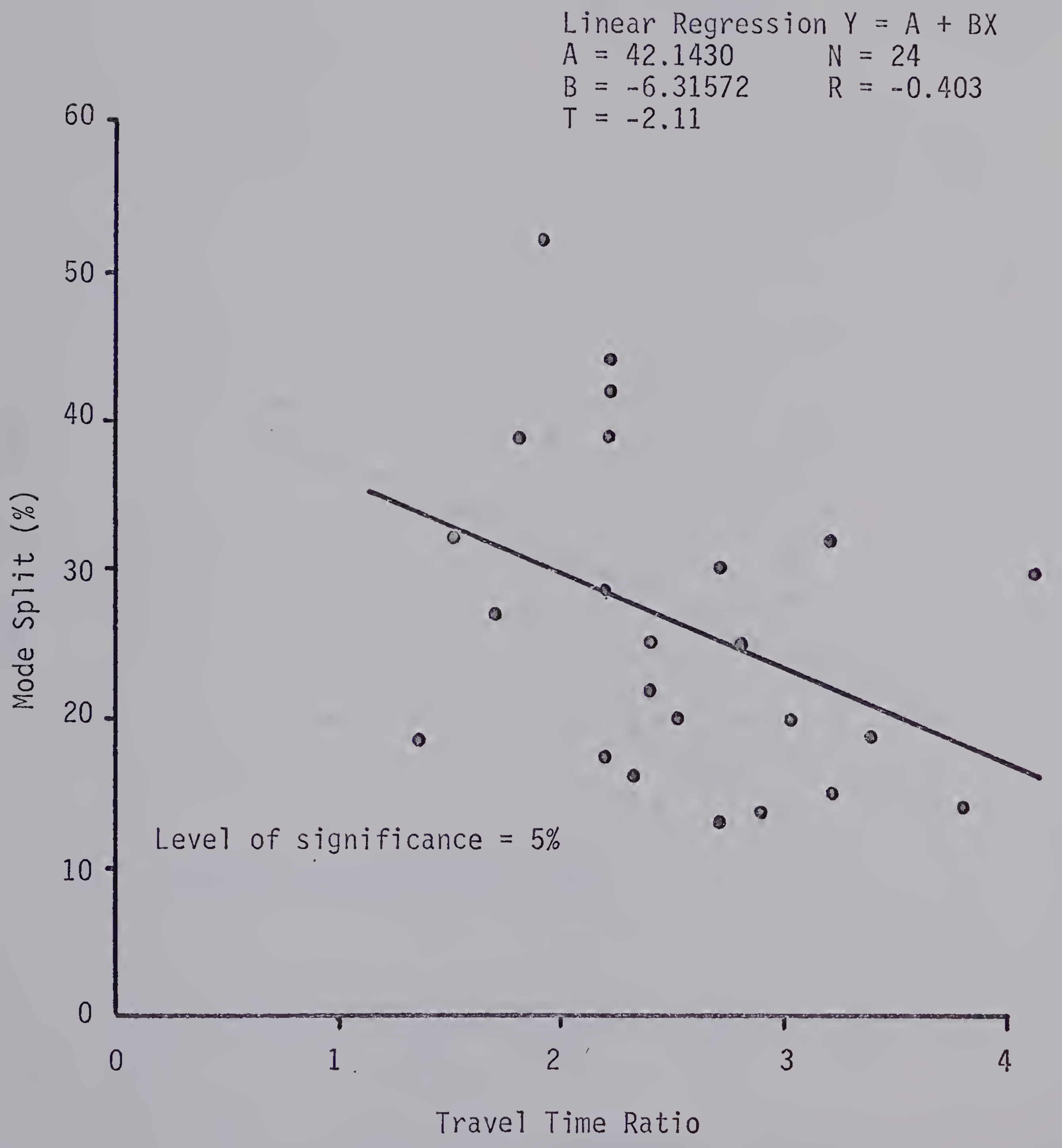


FIGURE D5

MODE SPLIT V'S TRAVEL TIME DIFFERENCE

PROGRAM V3

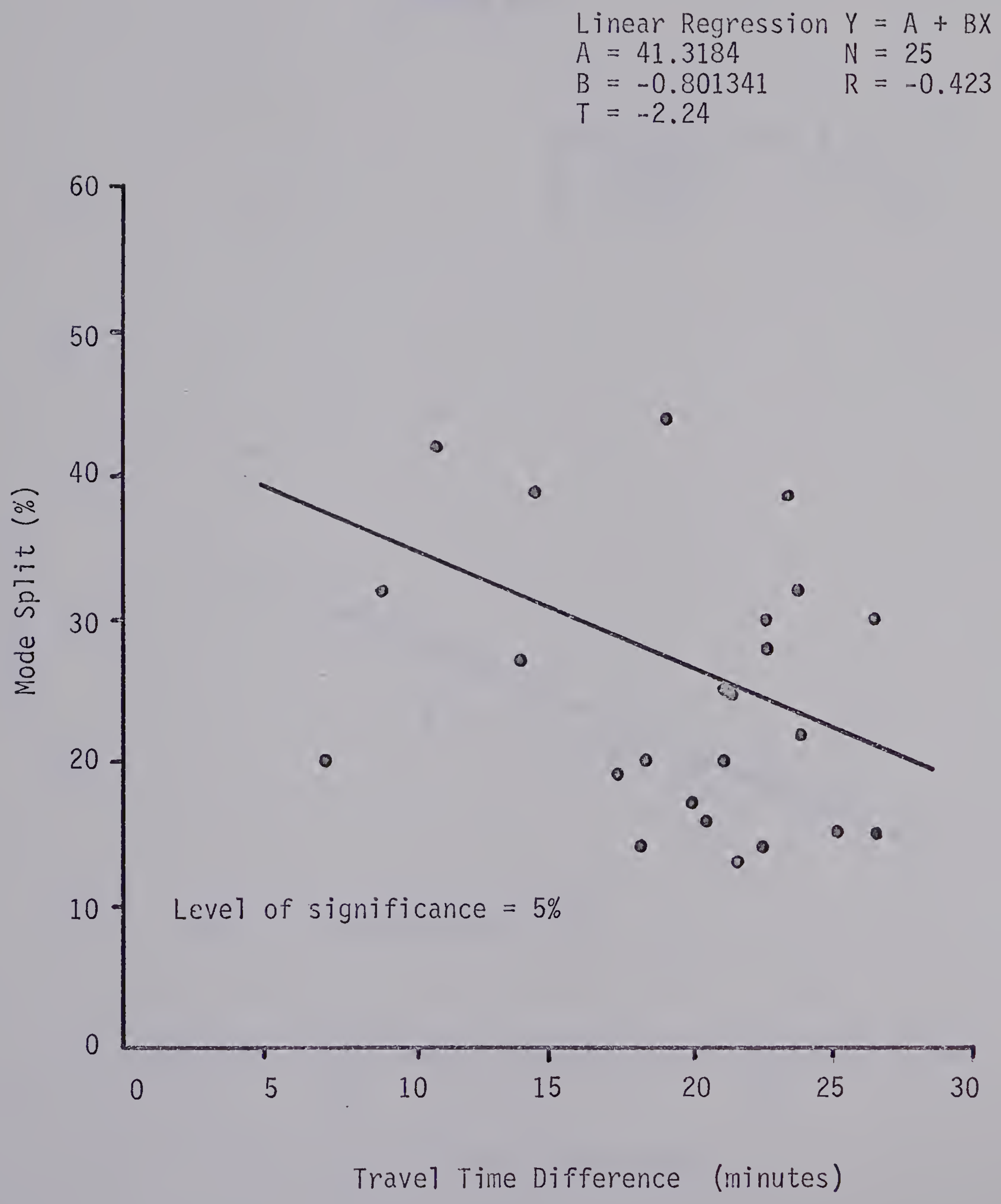


FIGURE D6

MODE SPLIT V'S TRAVEL TIME RATIO

PROGRAM V4

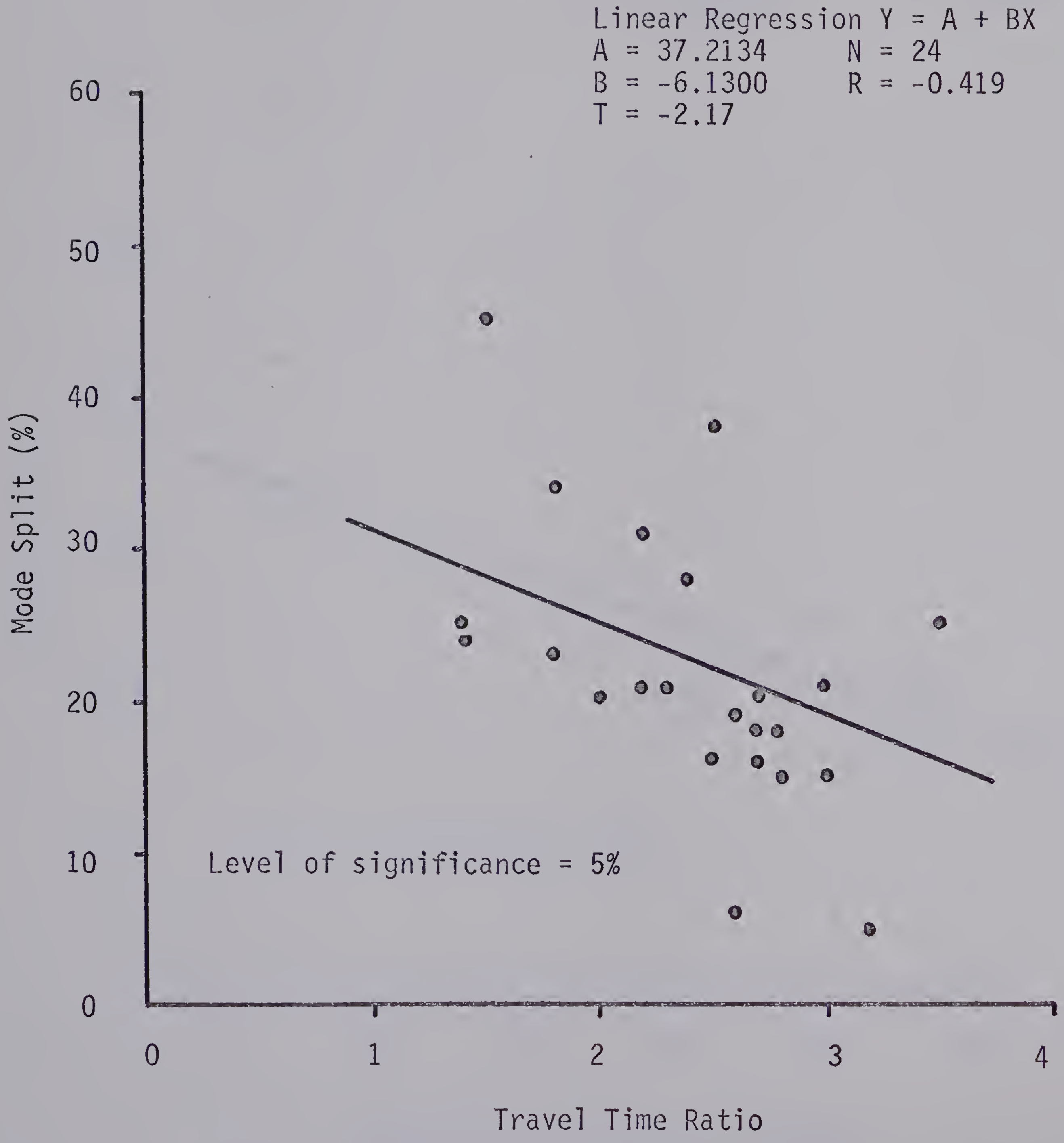


FIGURE D7

MODE SPLIT V'S TRAVEL TIME DIFFERENCE

PROGRAM V4

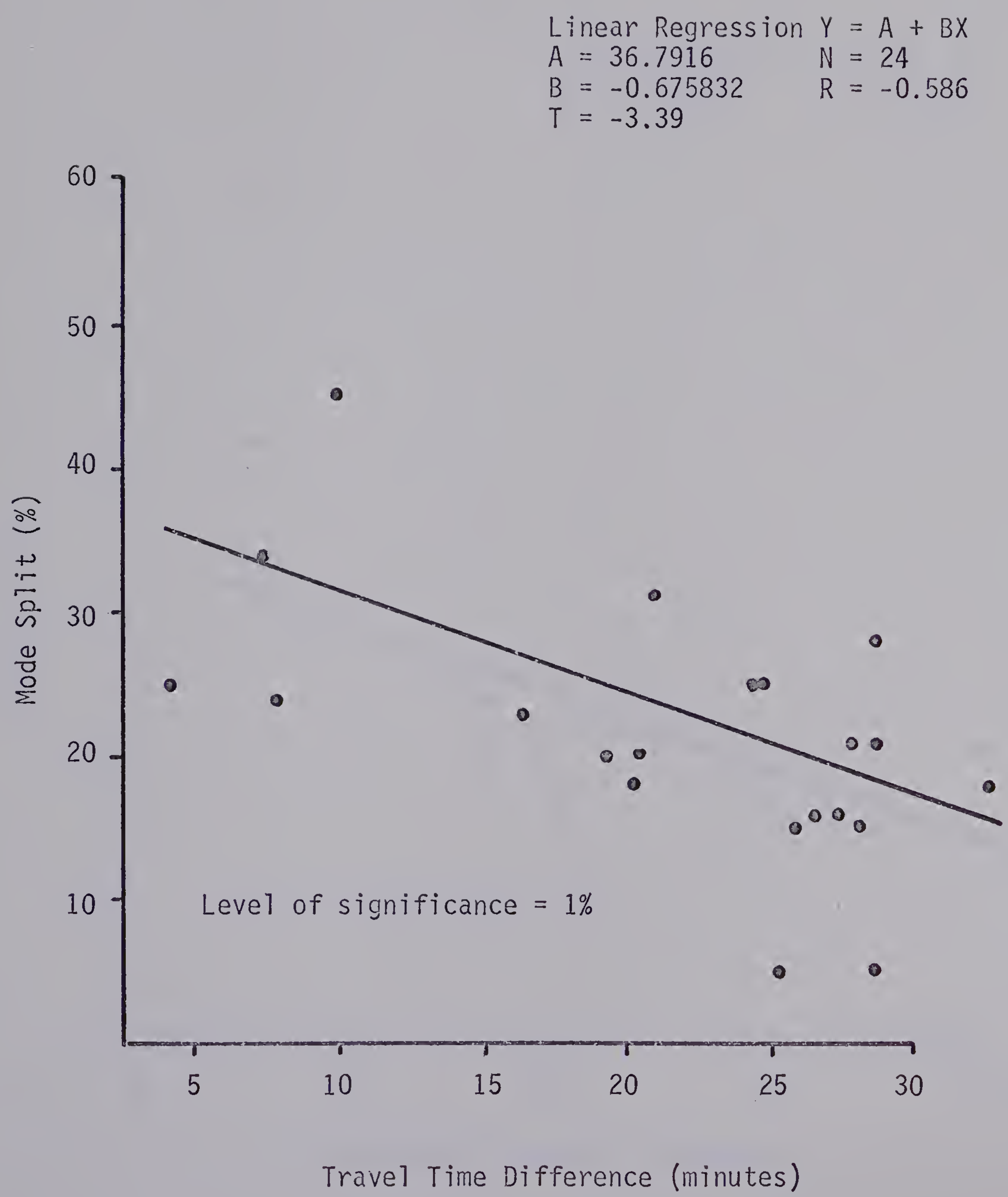


FIGURE D8

MODE SPLIT V'S BUS RUNNING TIME ONLY

PROGRAM V4

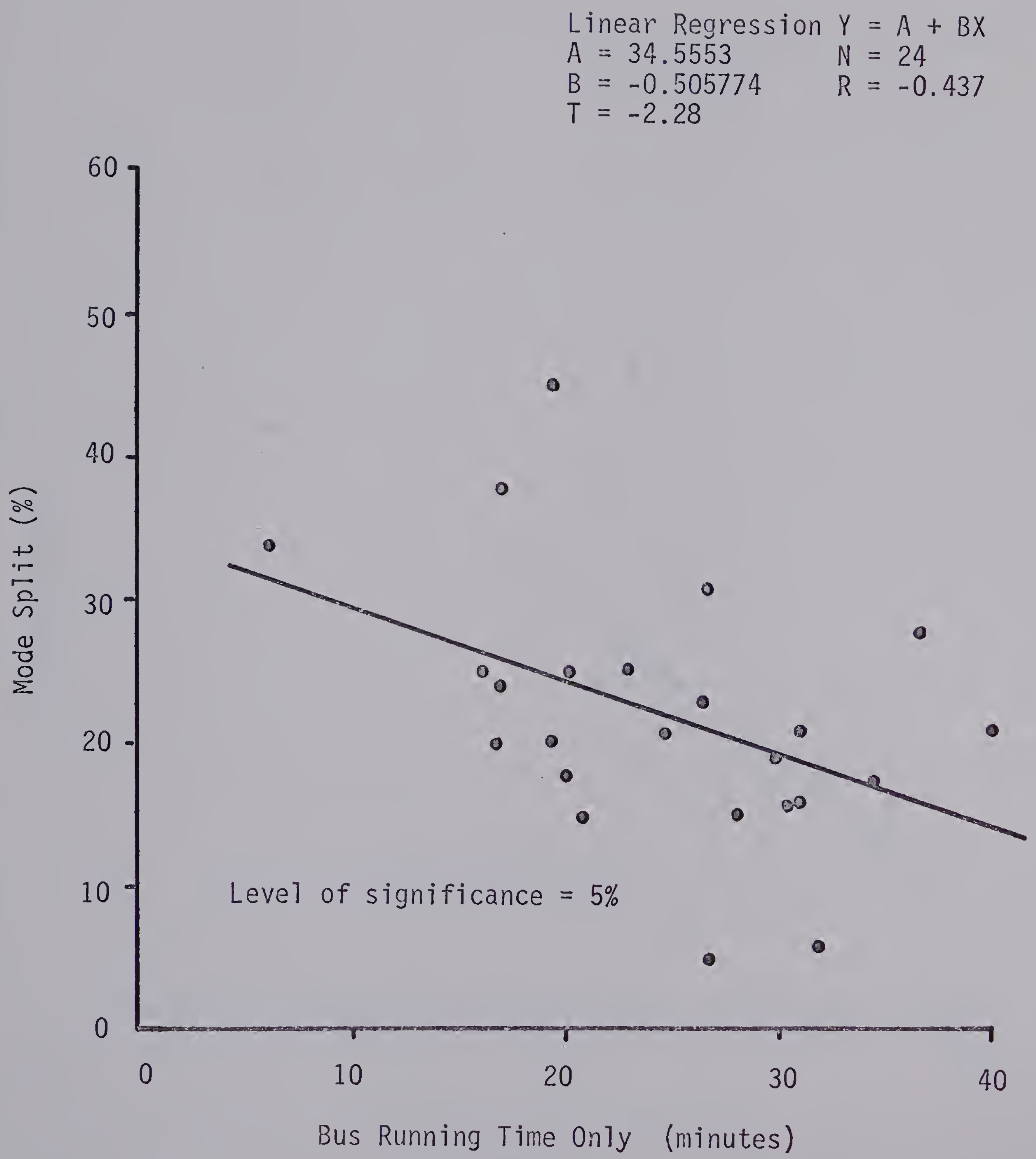


FIGURE D9

MODE SPLIT V'S BUS EXCESS TIME

PROGRAM V4

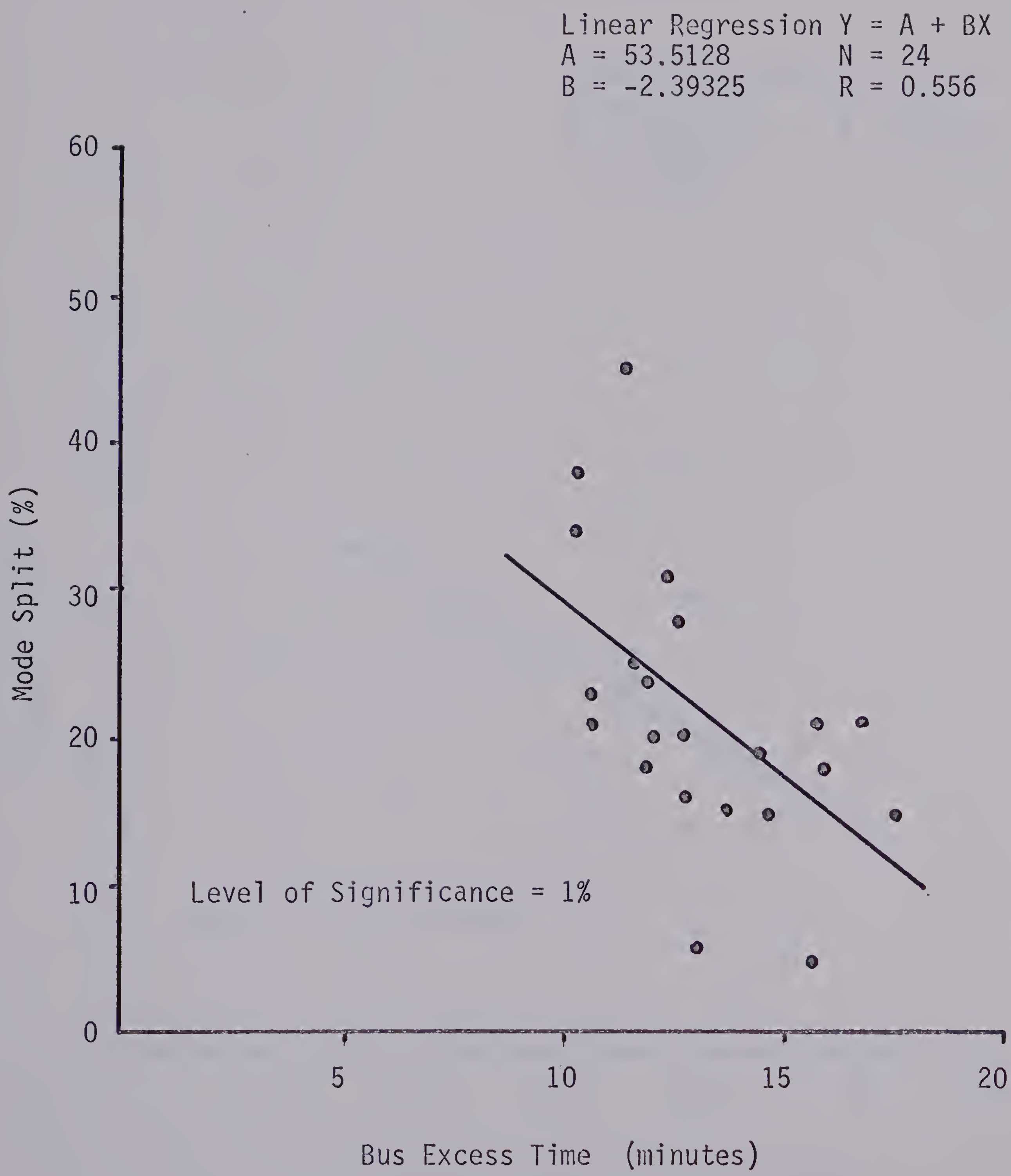


FIGURE D10

MODE SPLIT V'S TOTAL BUS TRAVEL TIME

PROGRAM V4

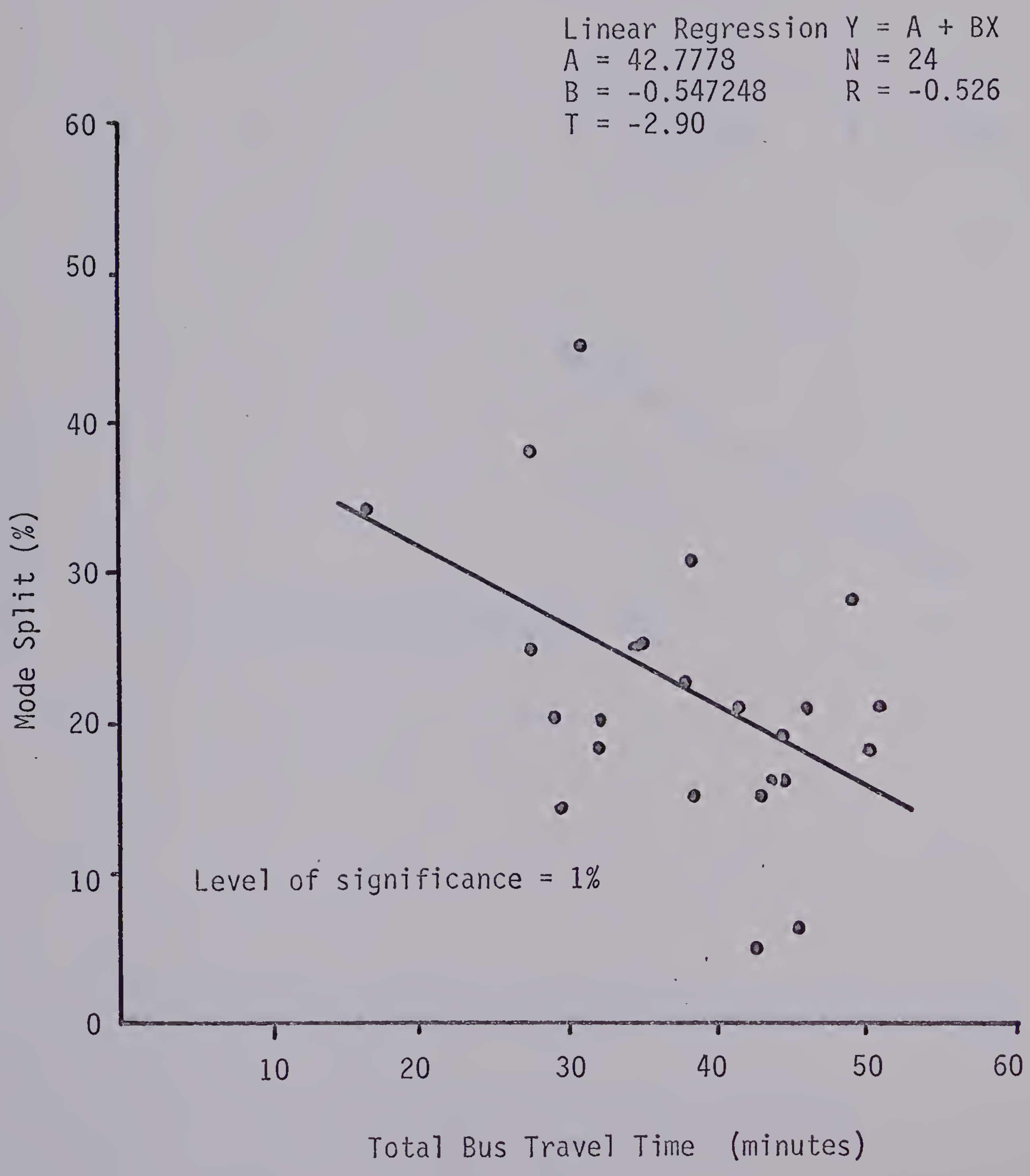


FIGURE D11

MODE SPLIT V'S TRAVEL TIME RATIO

PROGRAM E1

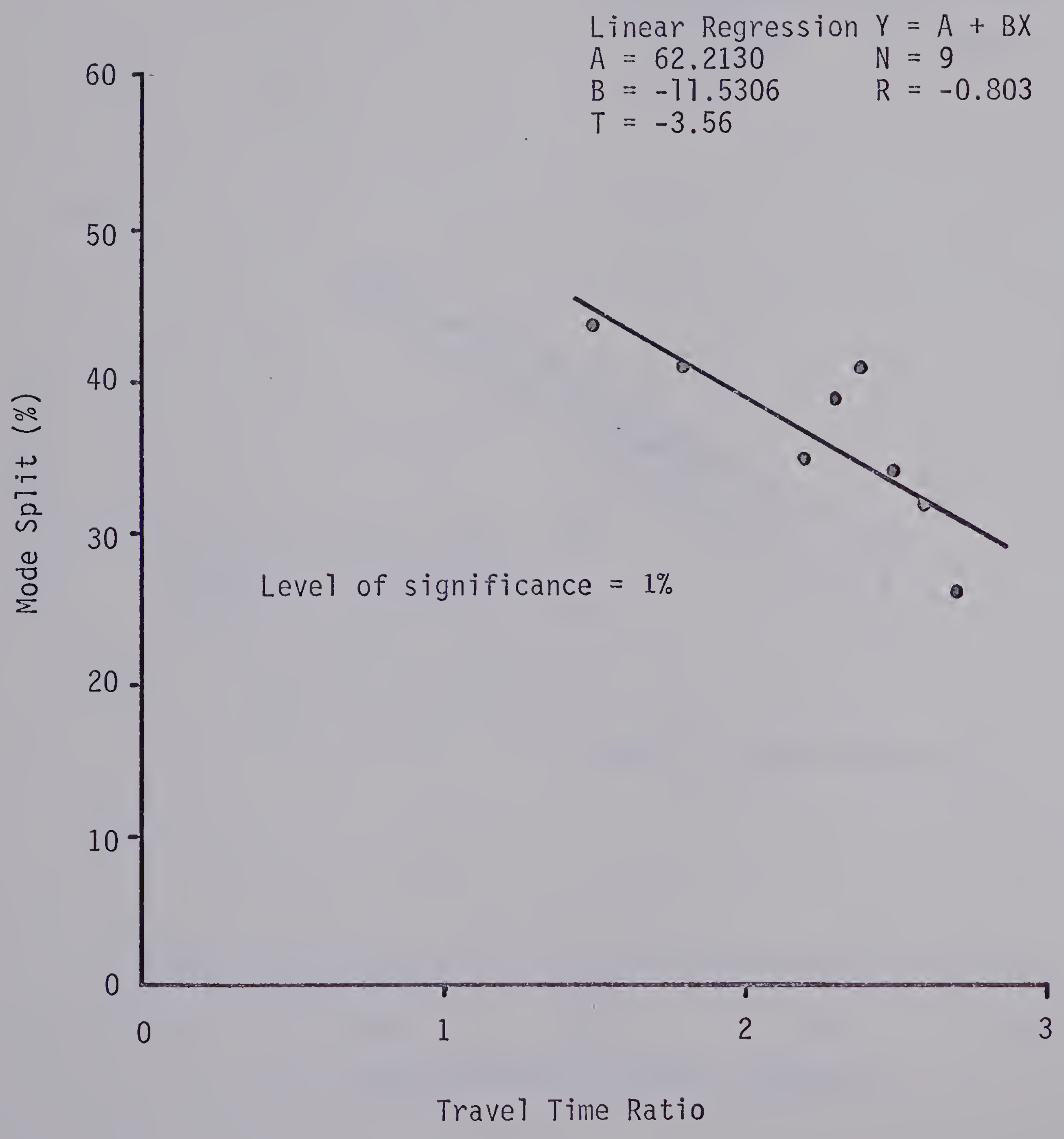


FIGURE D12

MODE SPLIT V'S TRAVEL TIME DIFFERENCE

PROGRAM E1

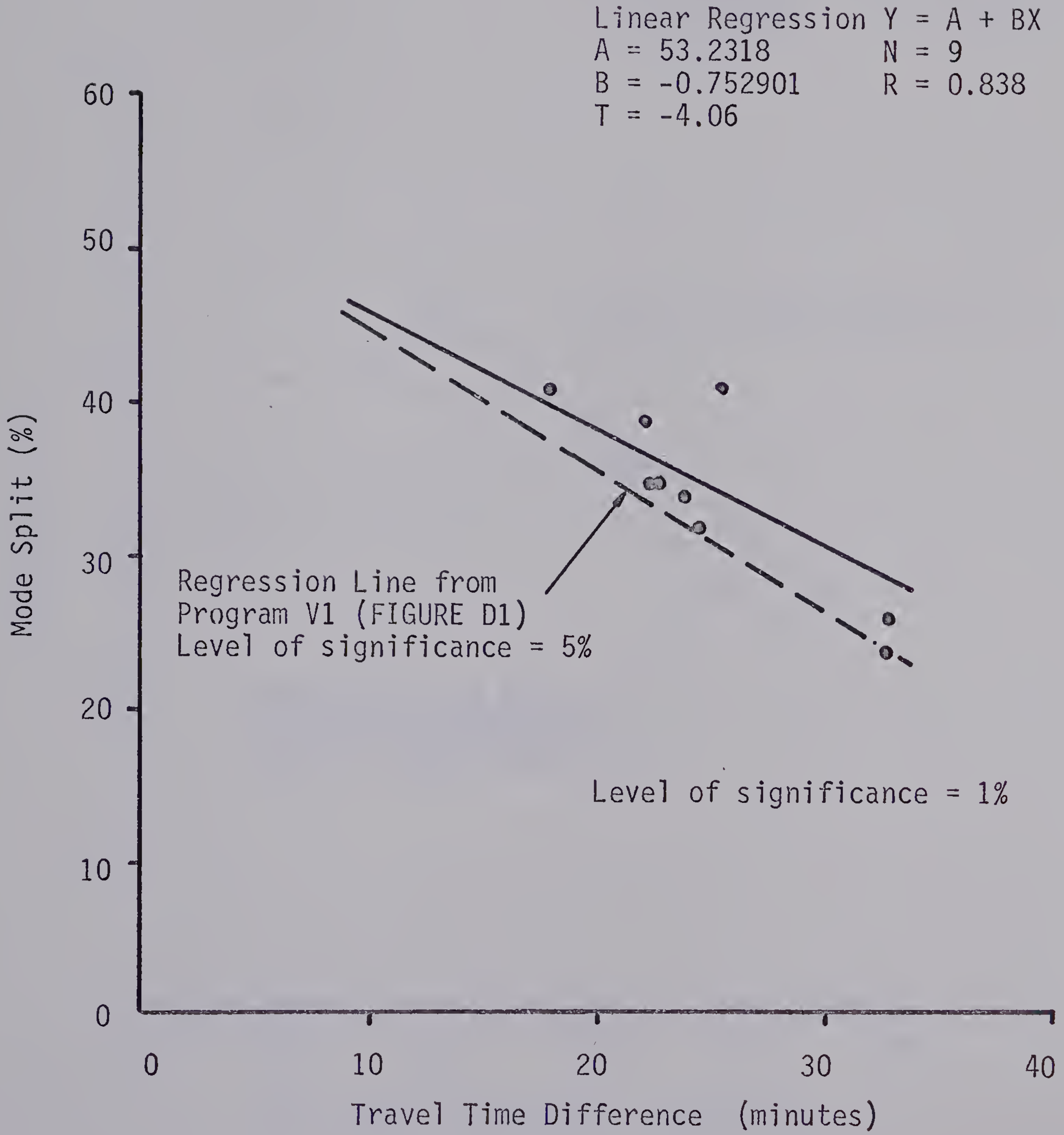


FIGURE D13

MODE SPLIT V'S BUS RUNNING TIME ONLY

PROGRAM E1

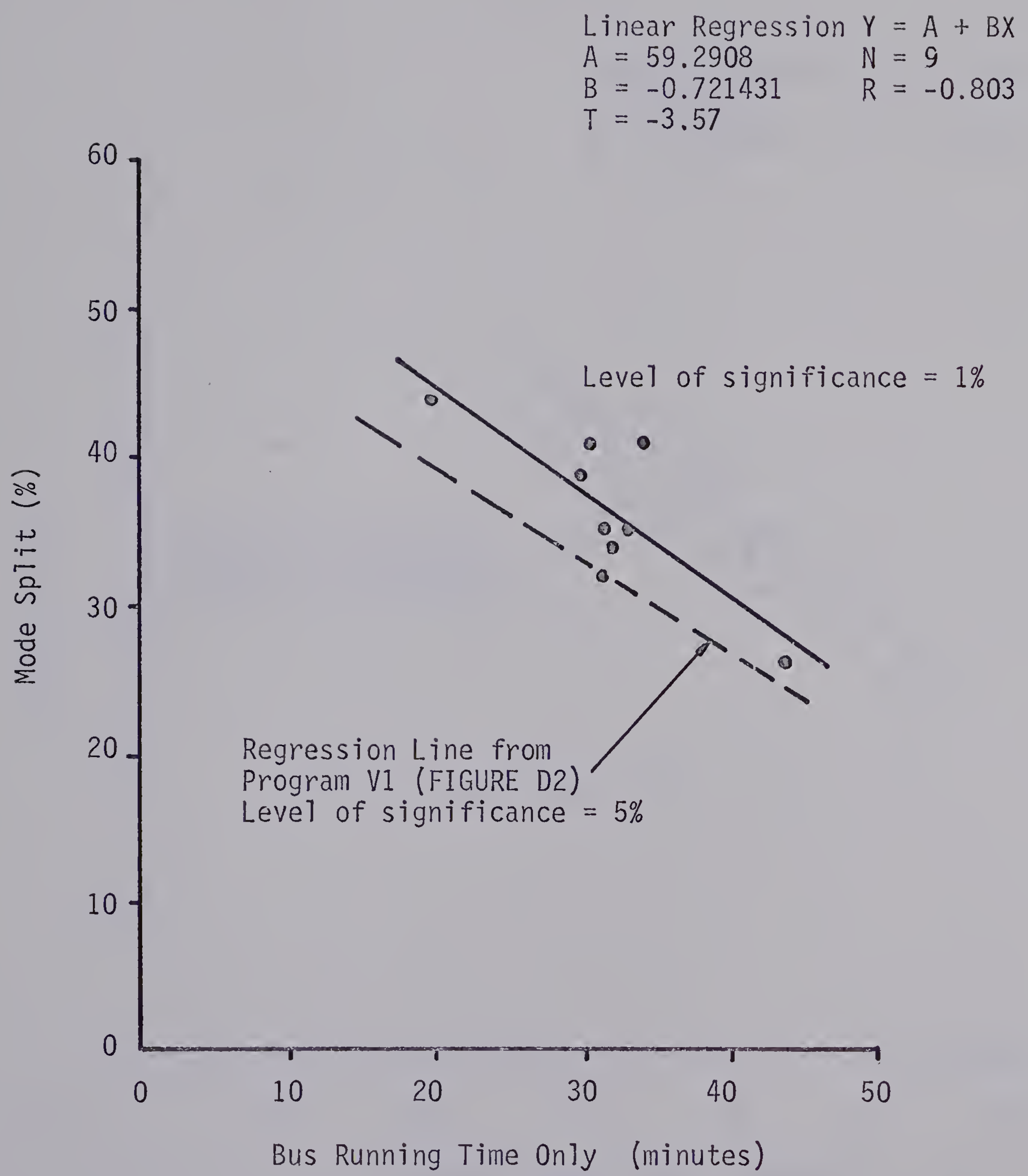


FIGURE D14

MODE SPLIT V'S TOTAL BUS TRAVEL TIME

PROGRAM E1

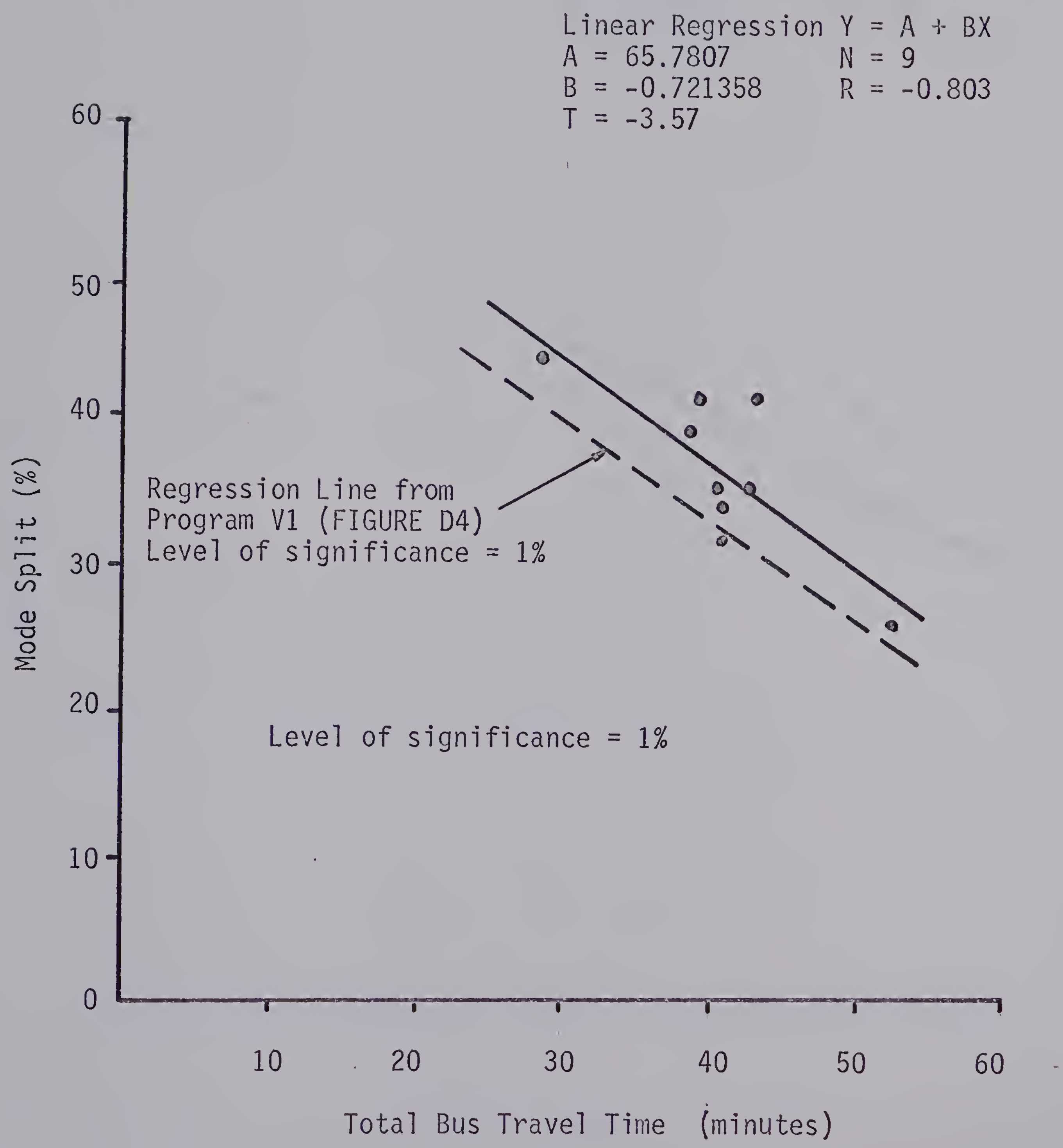


FIGURE D15

MODE SPLIT V'S TRAVEL TIME RATIO

PROGRAM E2

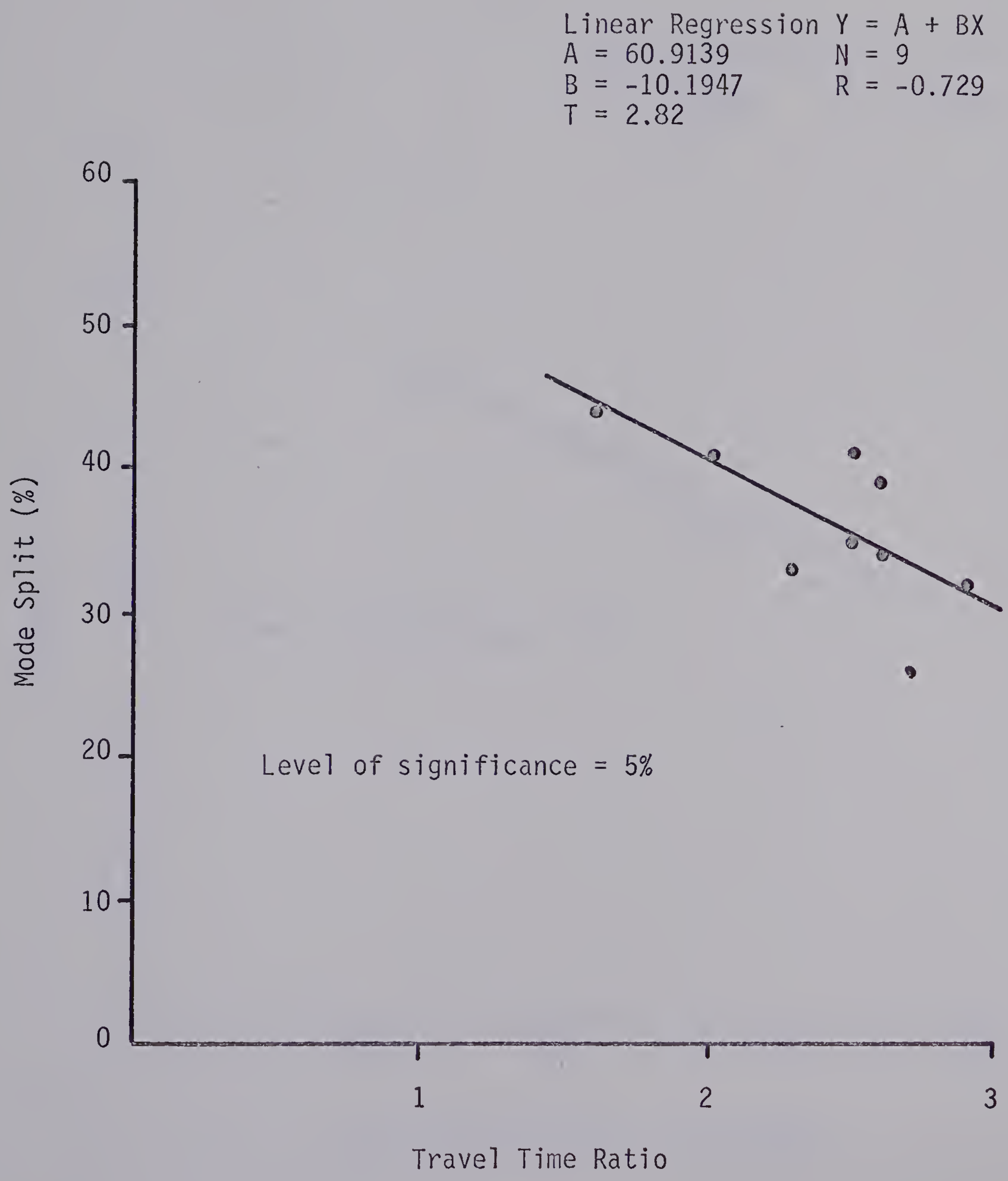


FIGURE D16

MODE SPLIT V'S TRAVEL TIME DIFFERENCE

PROGRAM E2

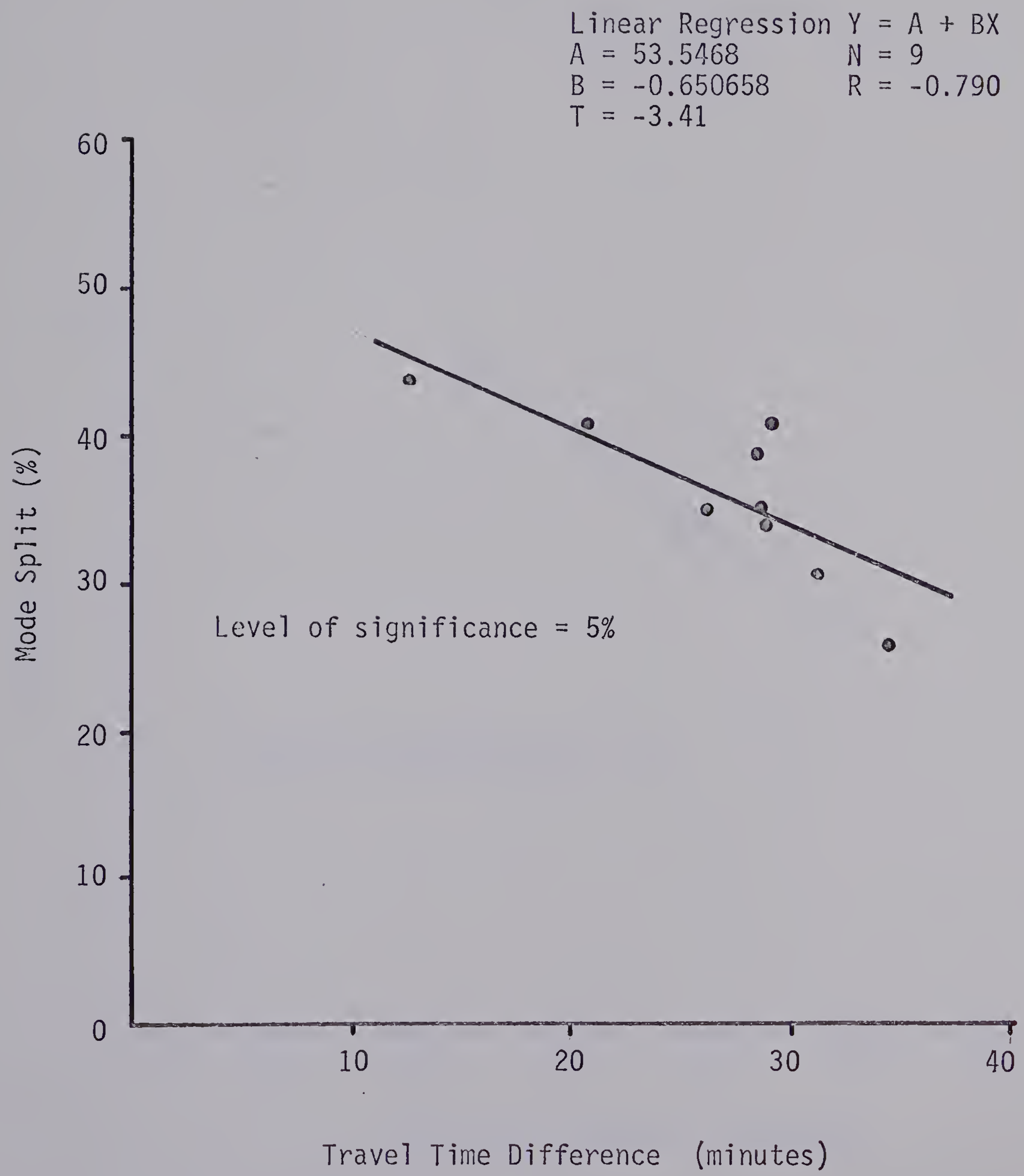


FIGURE D17

MODE SPLIT V'S BUS RUNNING TIME ONLY

PROGRAM E2

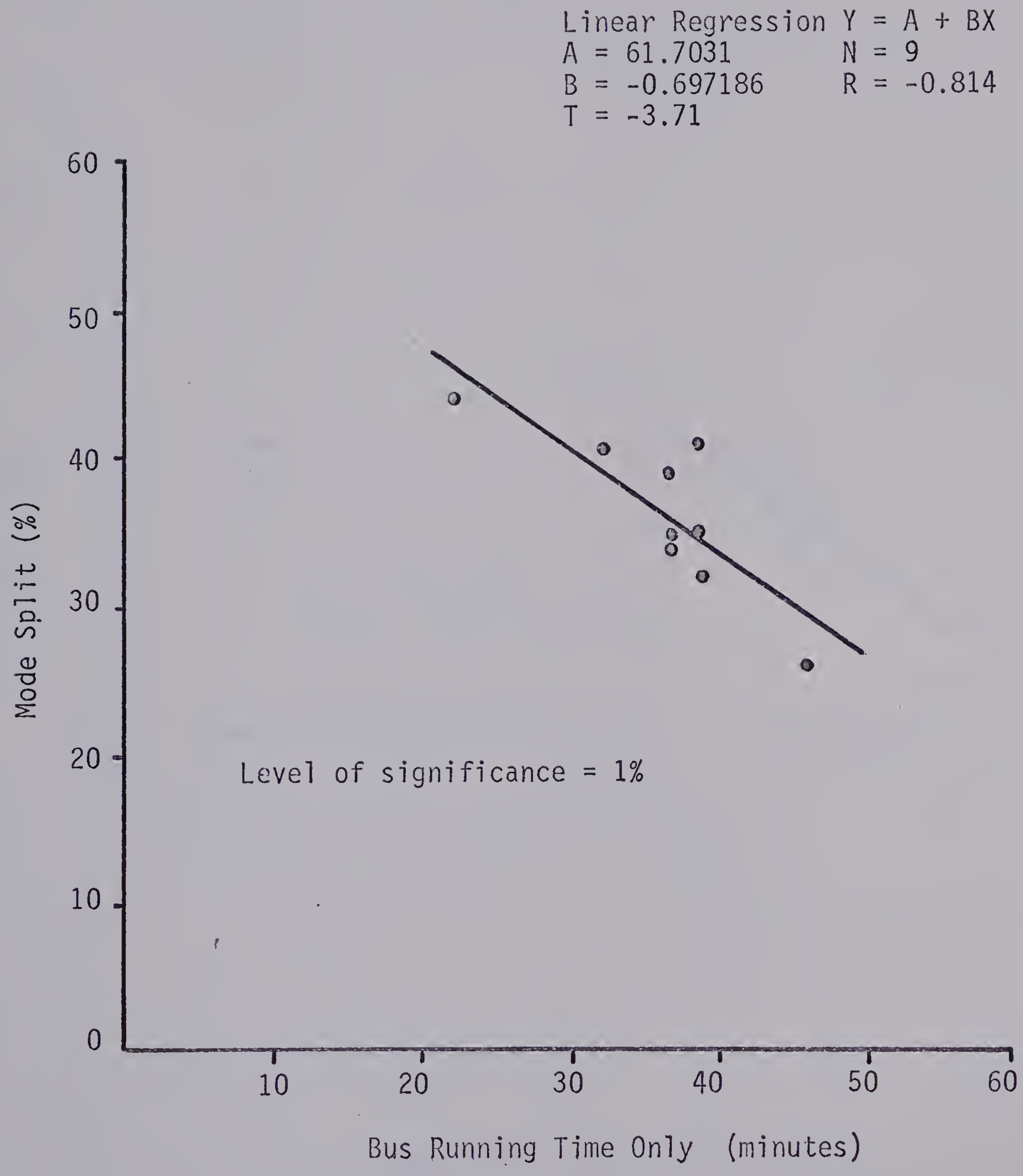


FIGURE D18

MODE SPLIT V'S TOTAL BUS TRAVEL TIME

PROGRAM E2

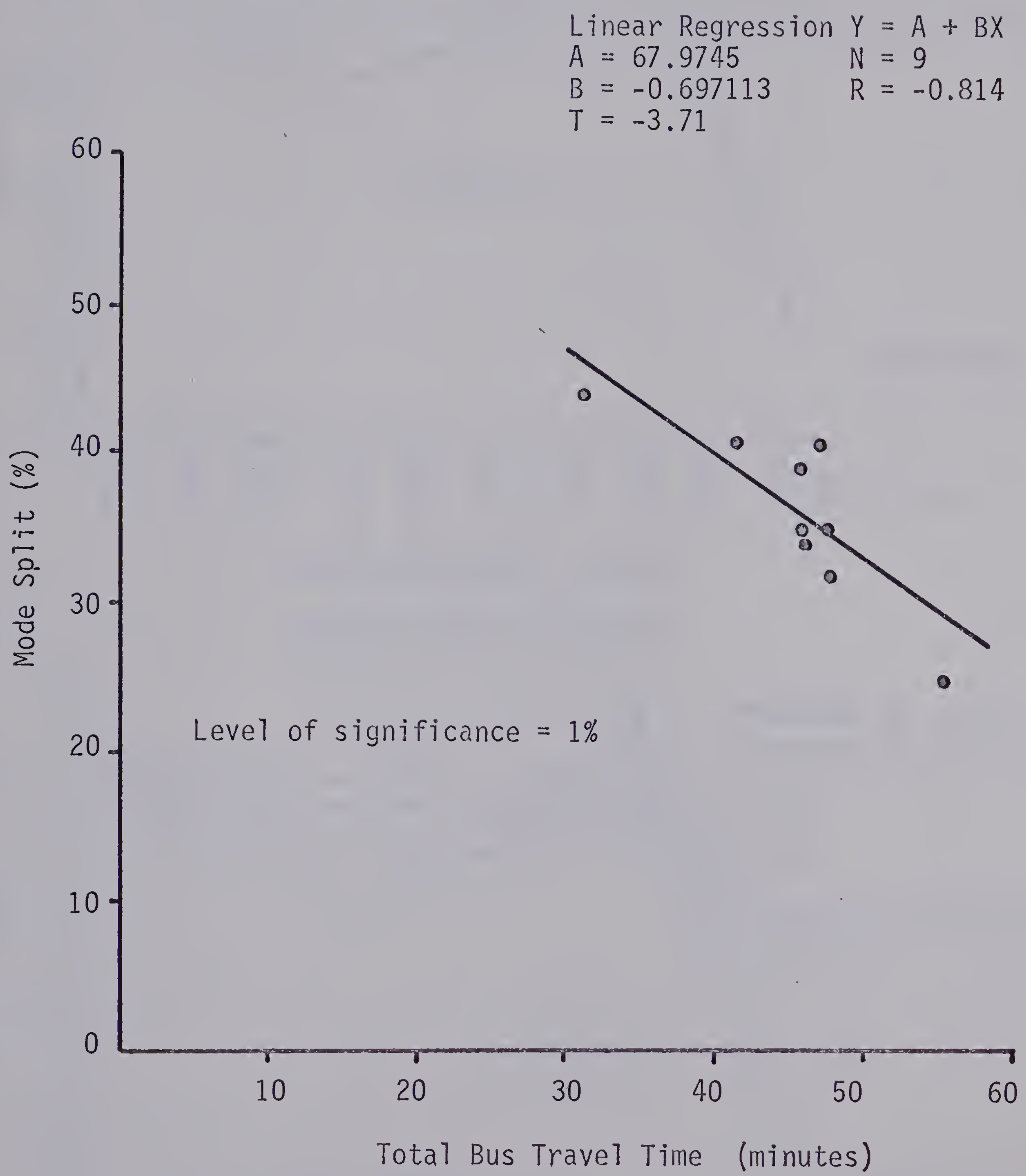


FIGURE D19

DESTINATION ZONE "0010"

"TRAVEL TIME RATIO"

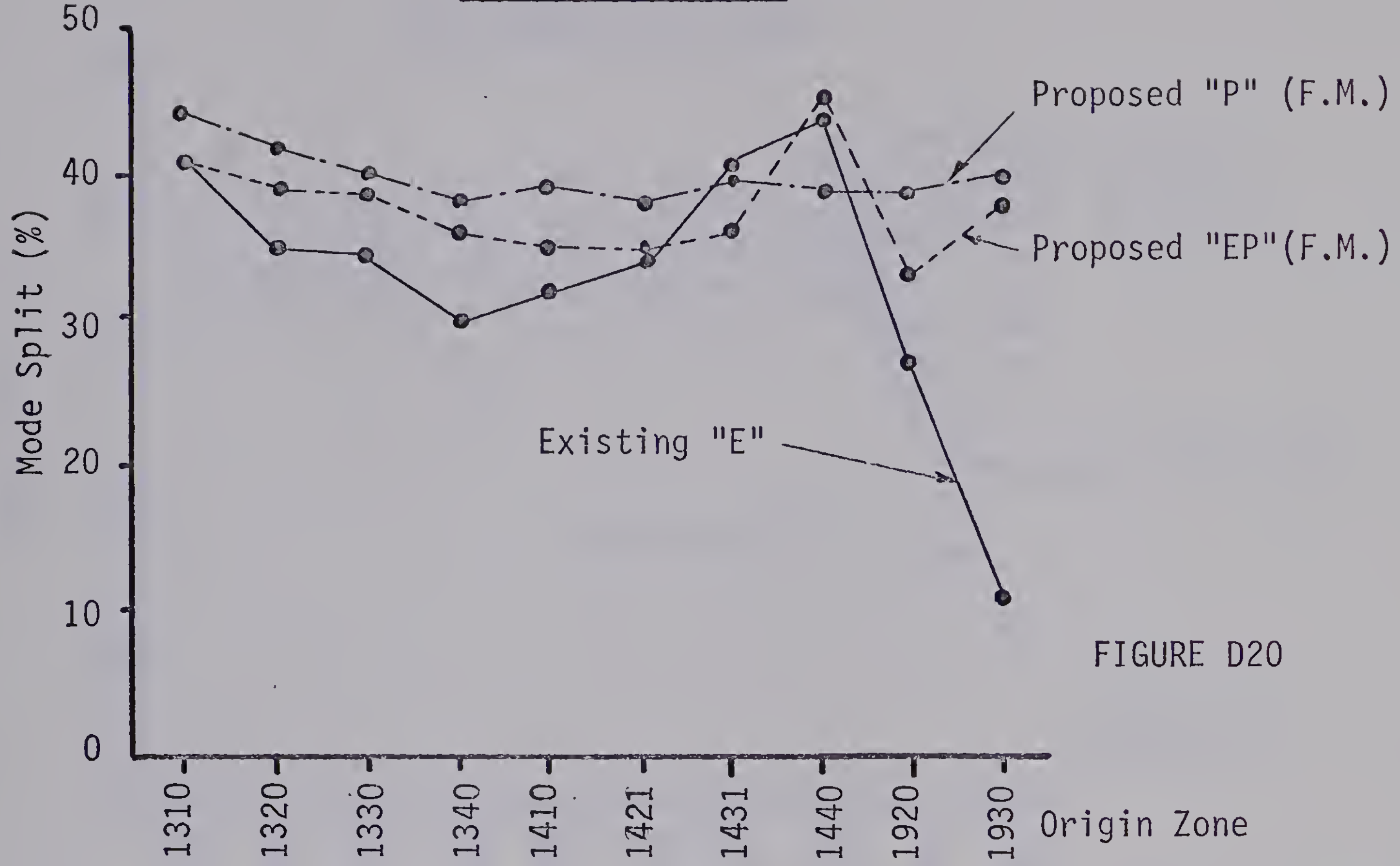


FIGURE D20

DESTINATION ZONE "0010"

"TRAVEL TIME DIFFERENCE"

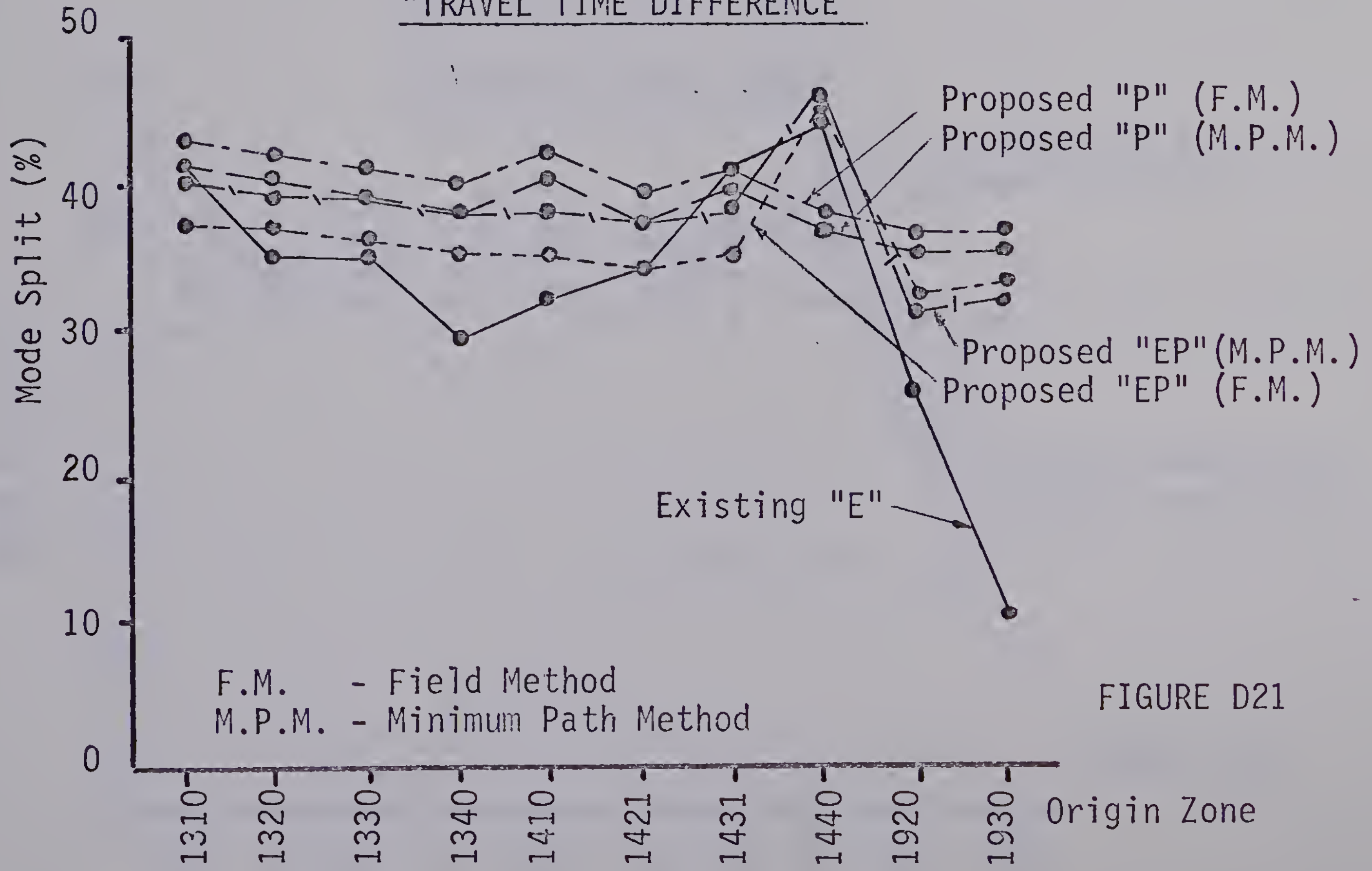


FIGURE D21

DESTINATION ZONE "0010"

"BUS RUNNING TIME ONLY"

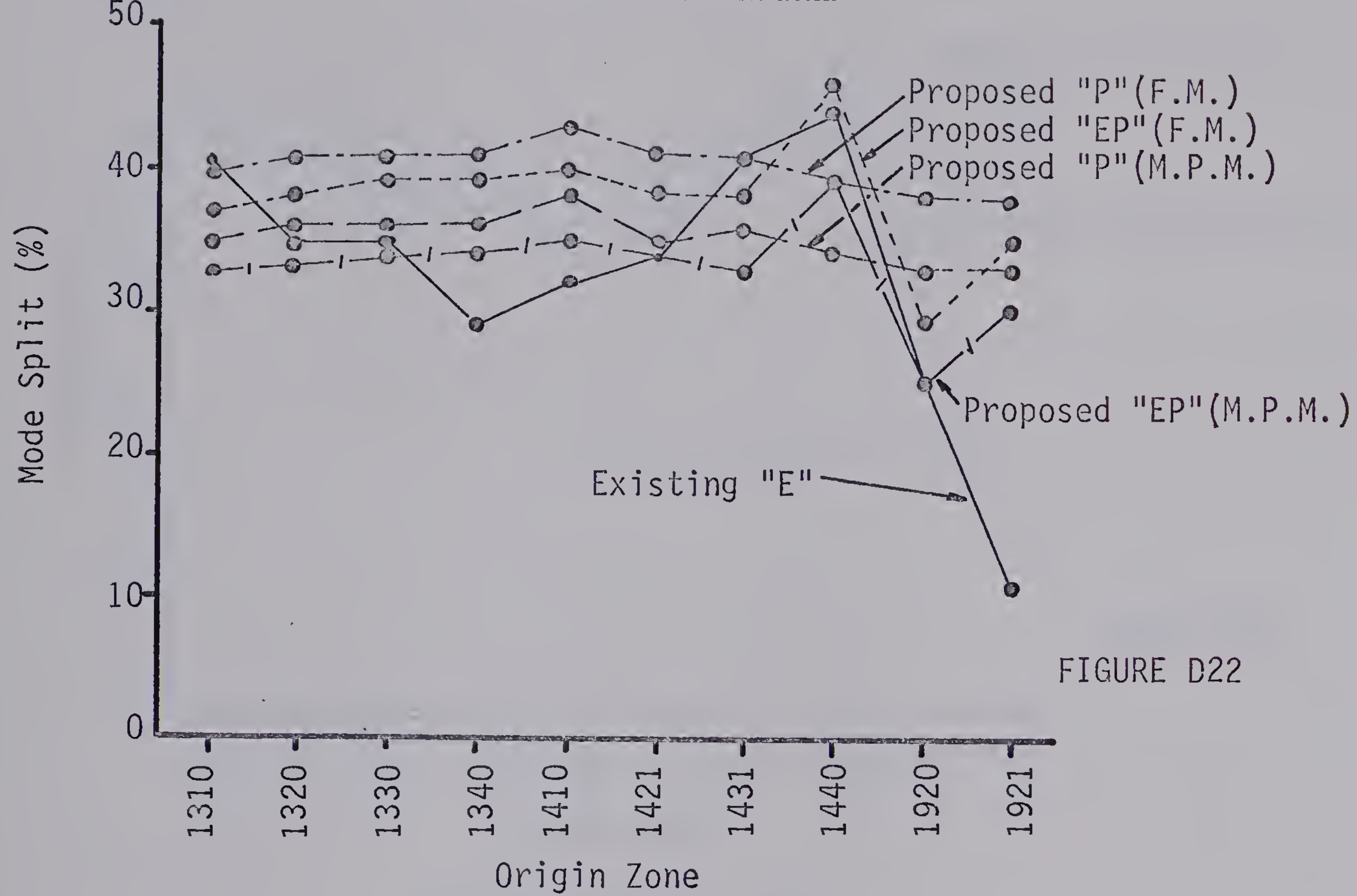


FIGURE D22

DESTINATION ZONE "0010"

"TOTAL BUS TRAVEL TIME"

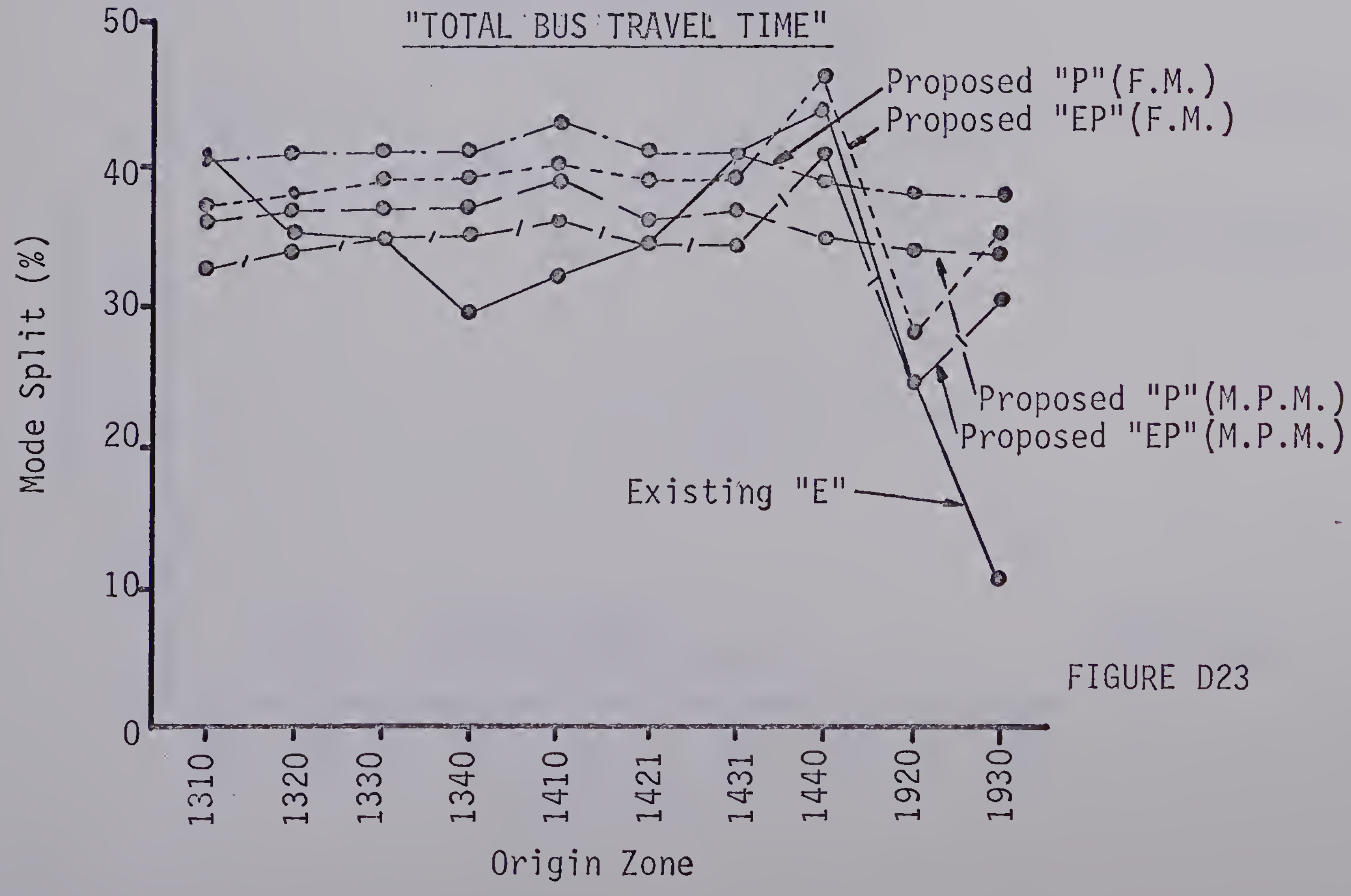


FIGURE D23

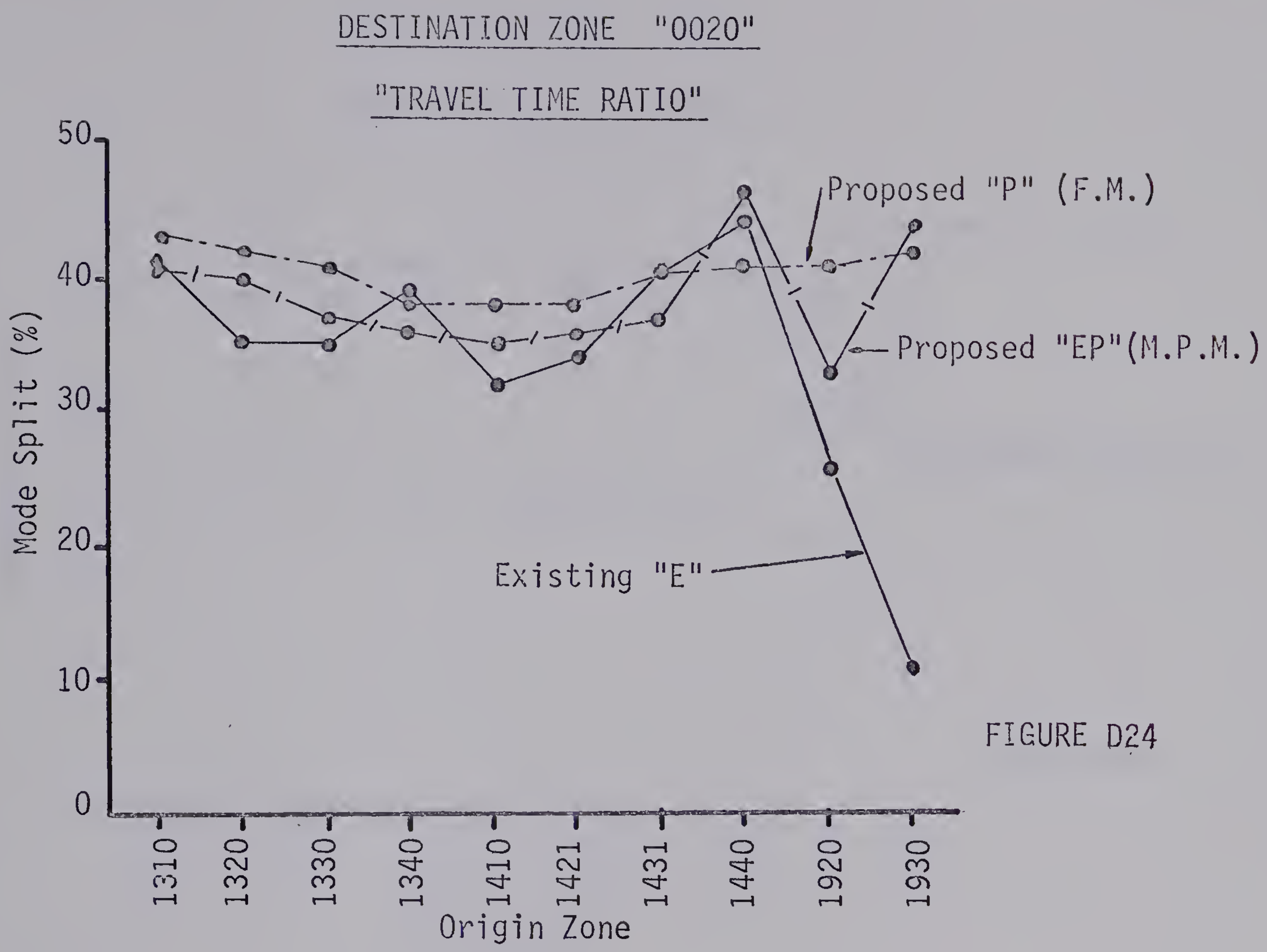


FIGURE D24

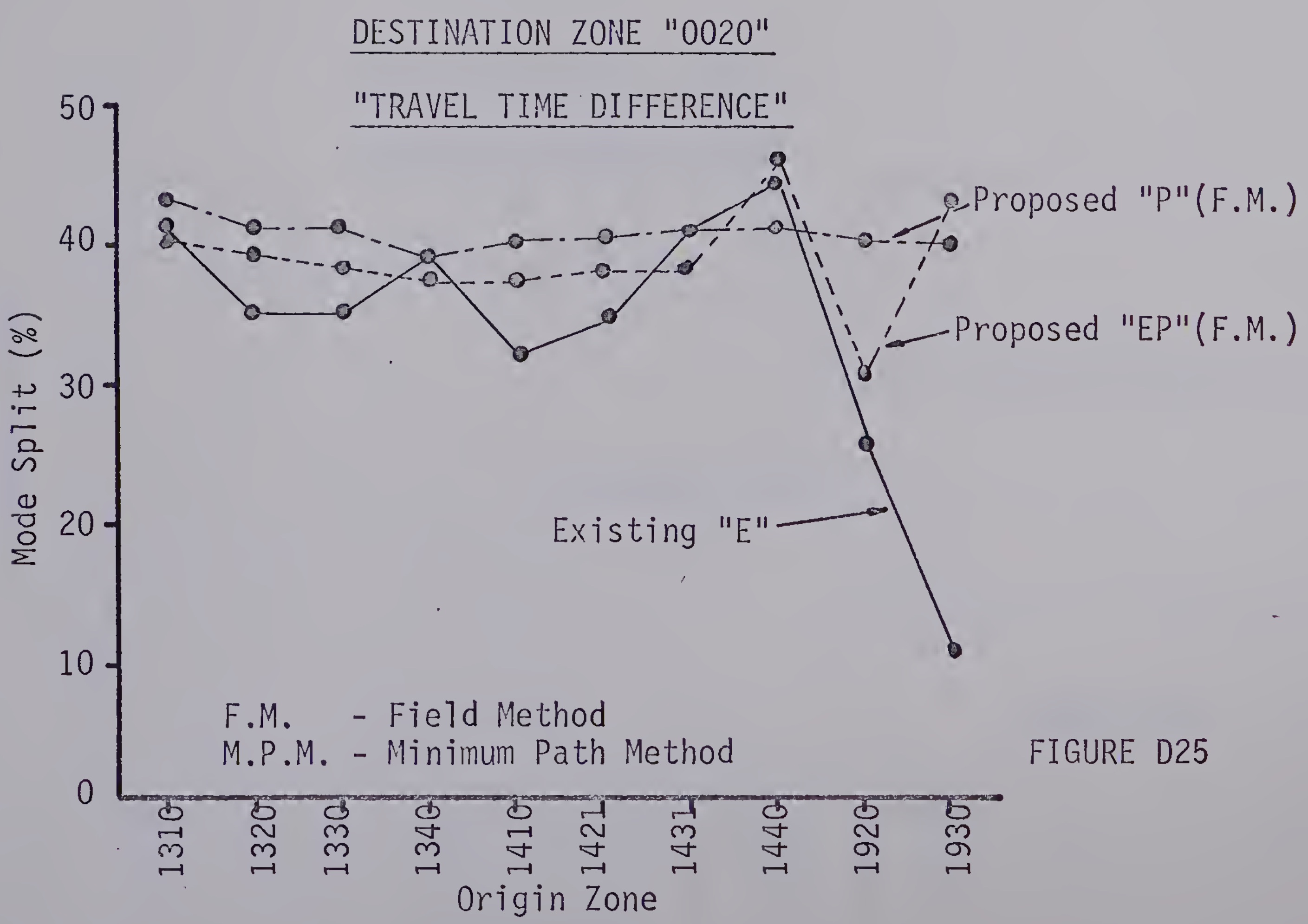


FIGURE D25

DESTINATION ZONE "0020"

"BUS RUNNING TIME ONLY"

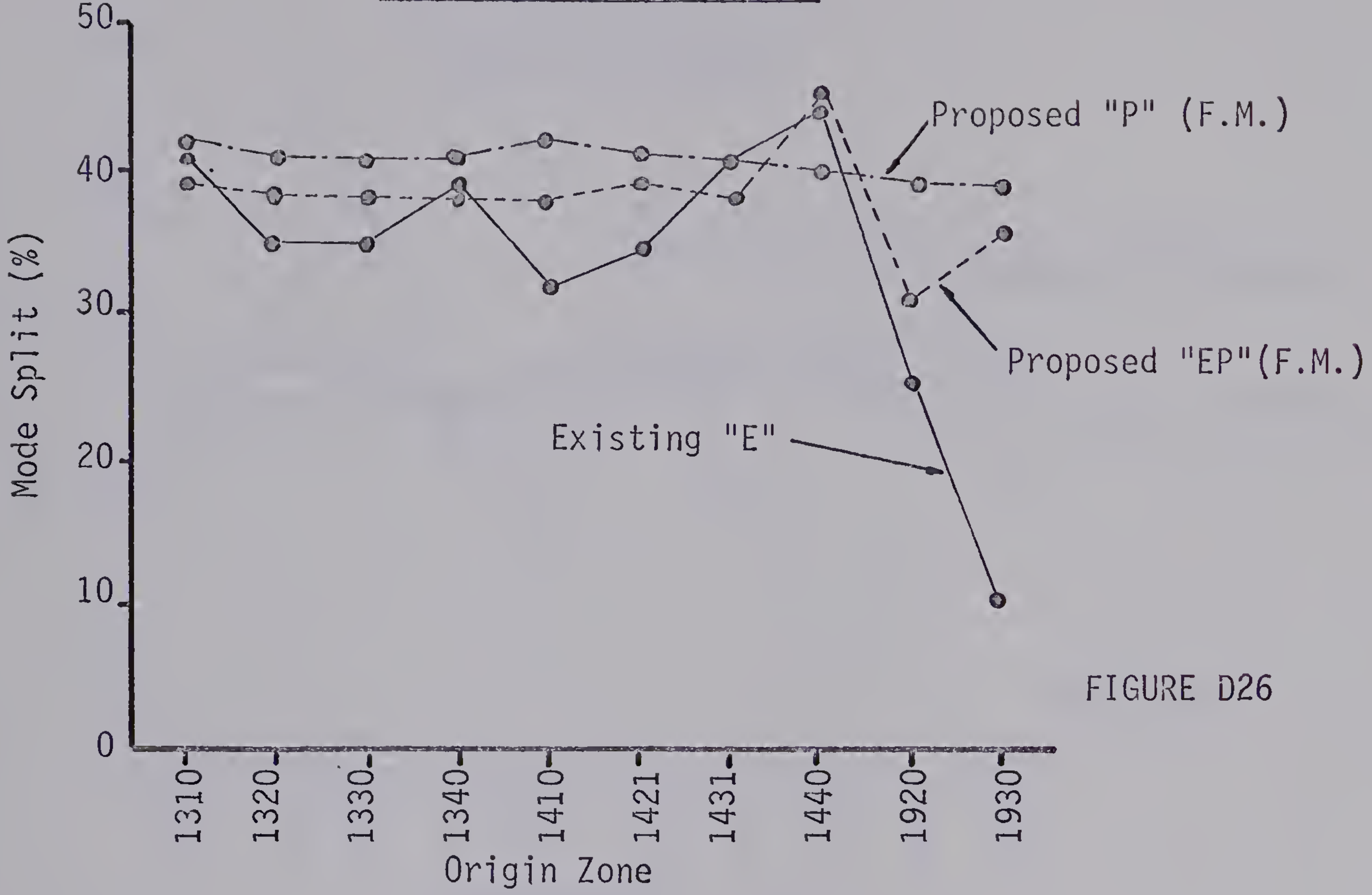
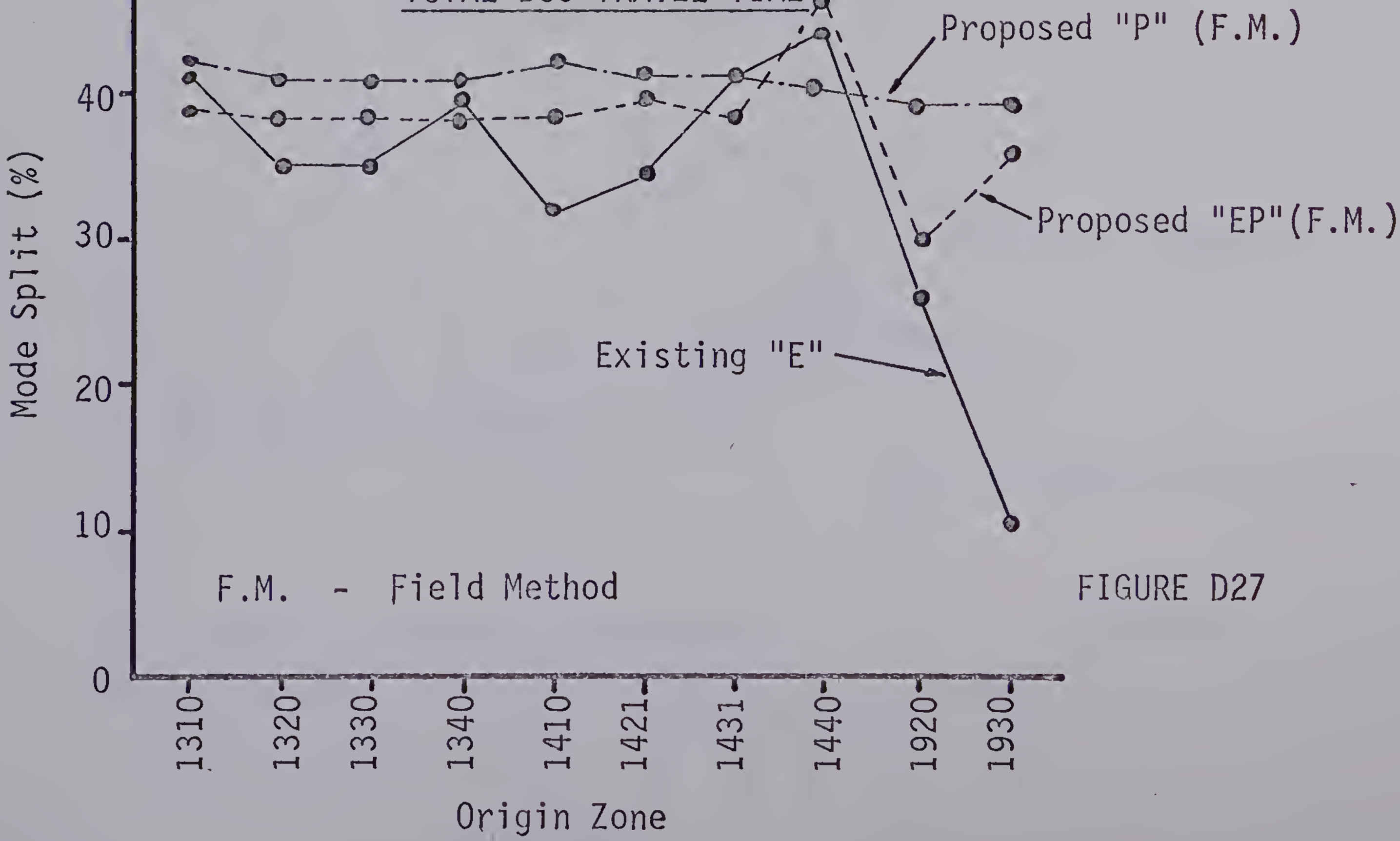


FIGURE D26

DESTINATION ZONE "0020"

"TOTAL BUS TRAVEL TIME"



F.M. - Field Method

FIGURE D27

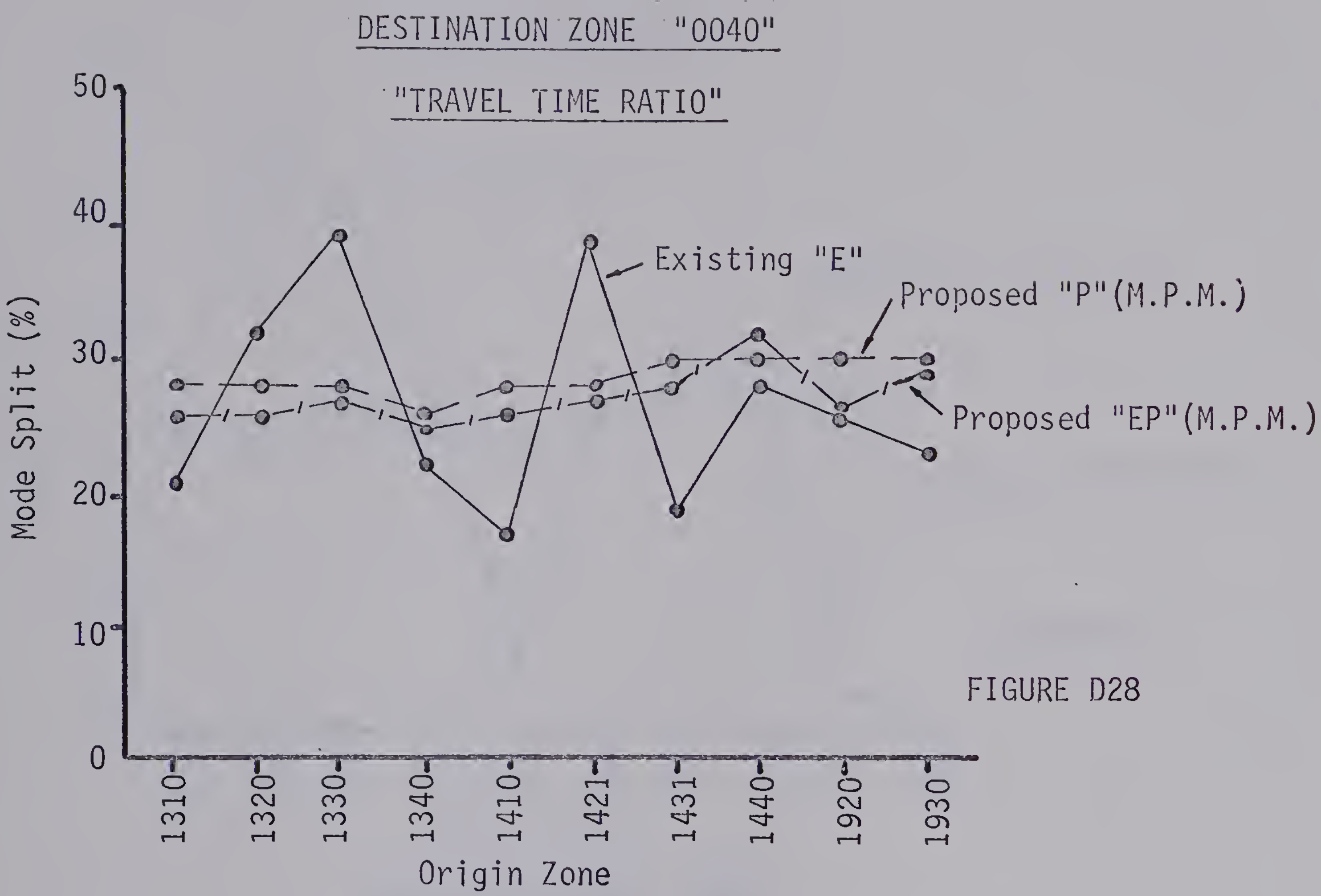


FIGURE D28

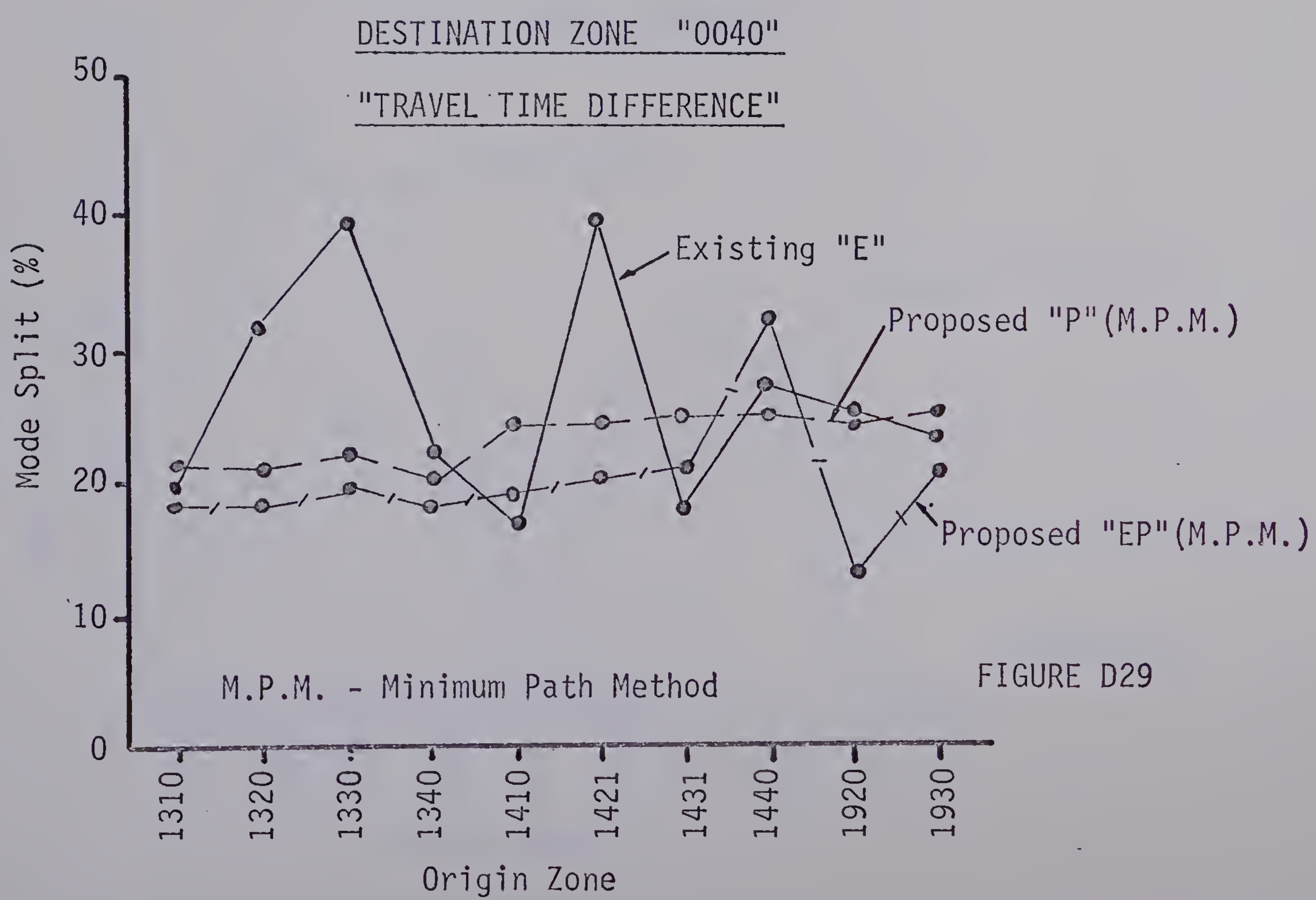


FIGURE D29

DESTINATION ZONE "0060"

"TRAVEL TIME RATIO"

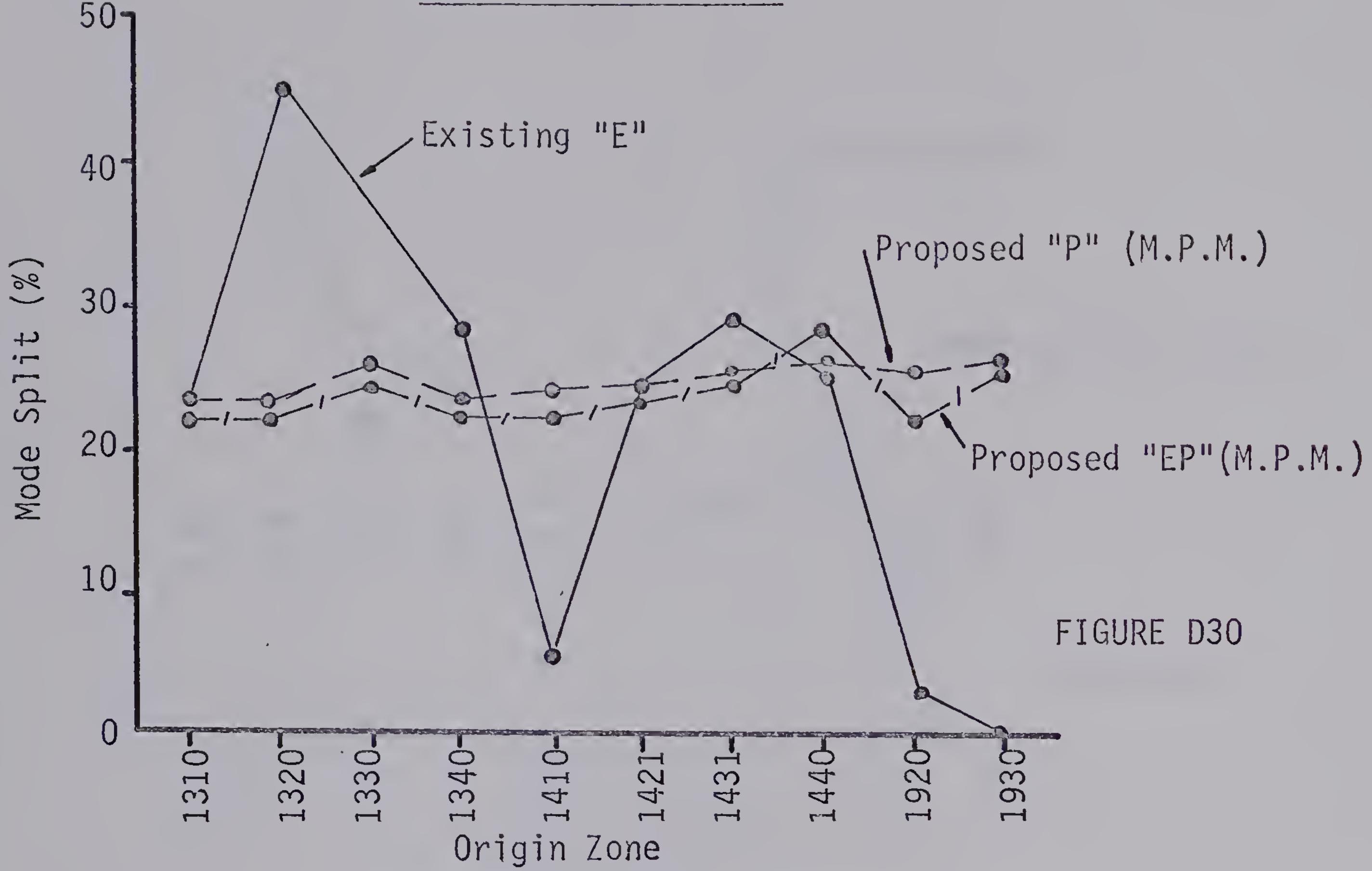


FIGURE D30

DESTINATION ZONE "0060"

"TRAVEL TIME DIFFERENCE"

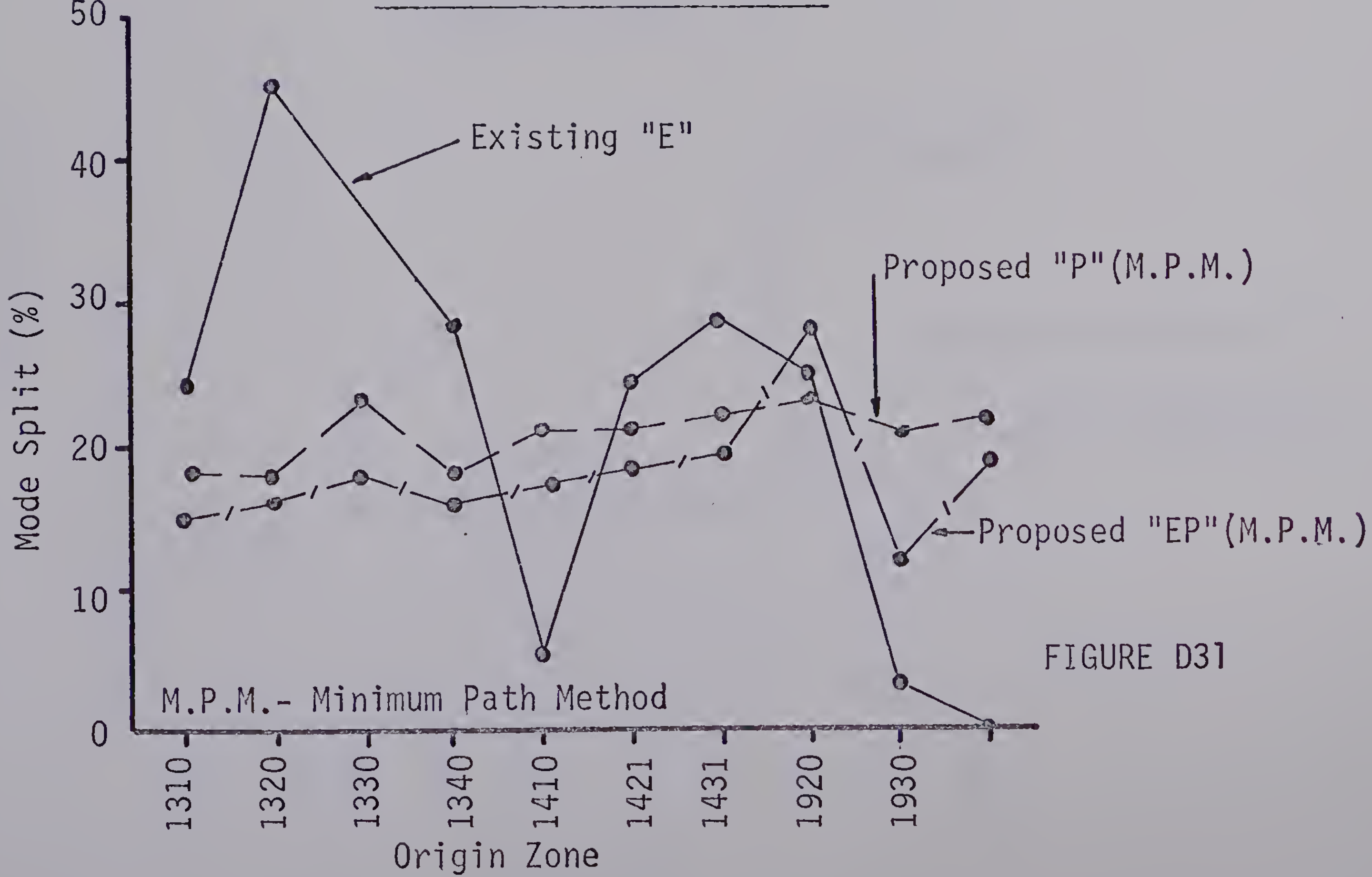


FIGURE D31

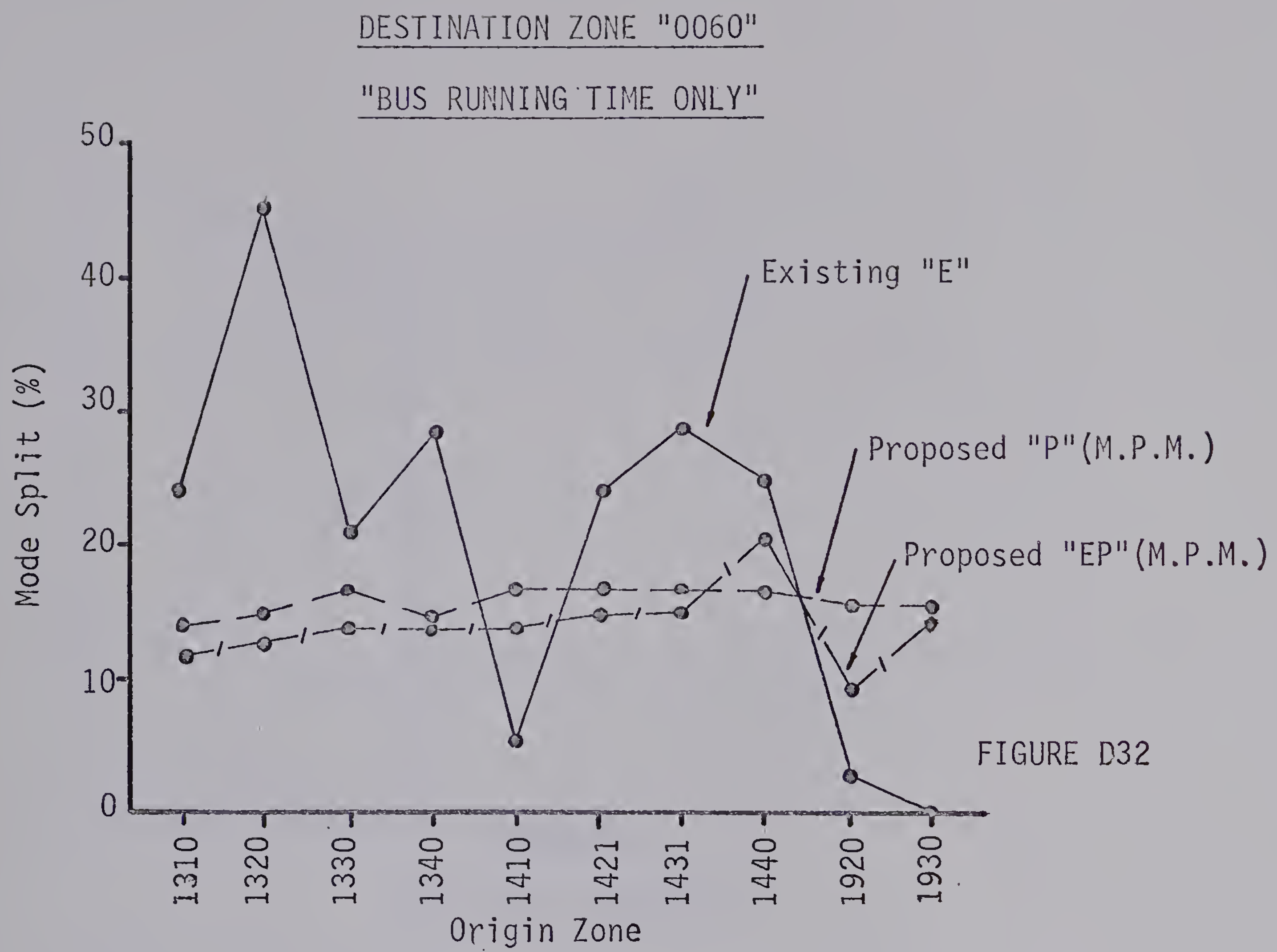


FIGURE D32

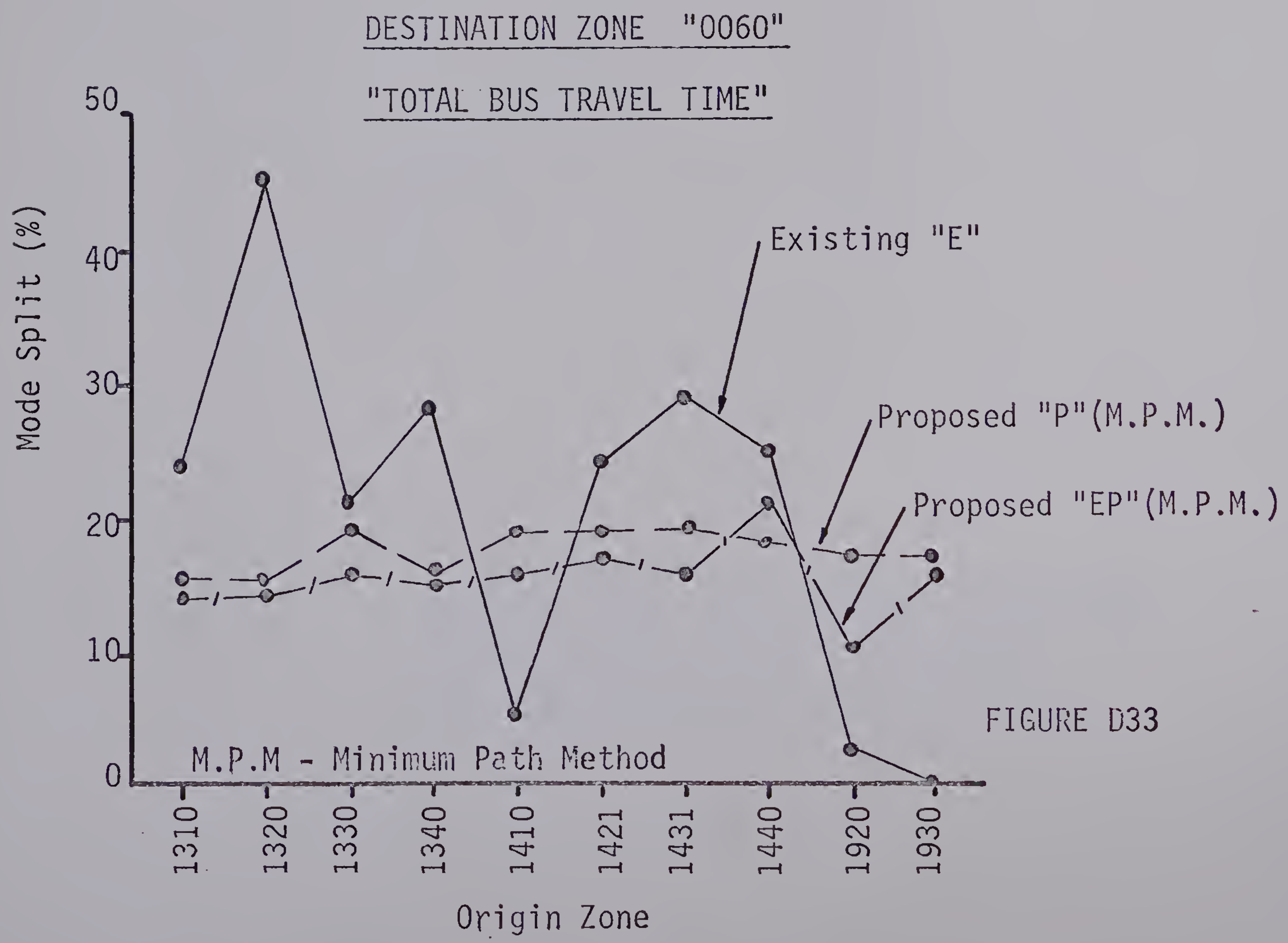


FIGURE D33

APPENDIX E

BUS ROUTE LOCATION

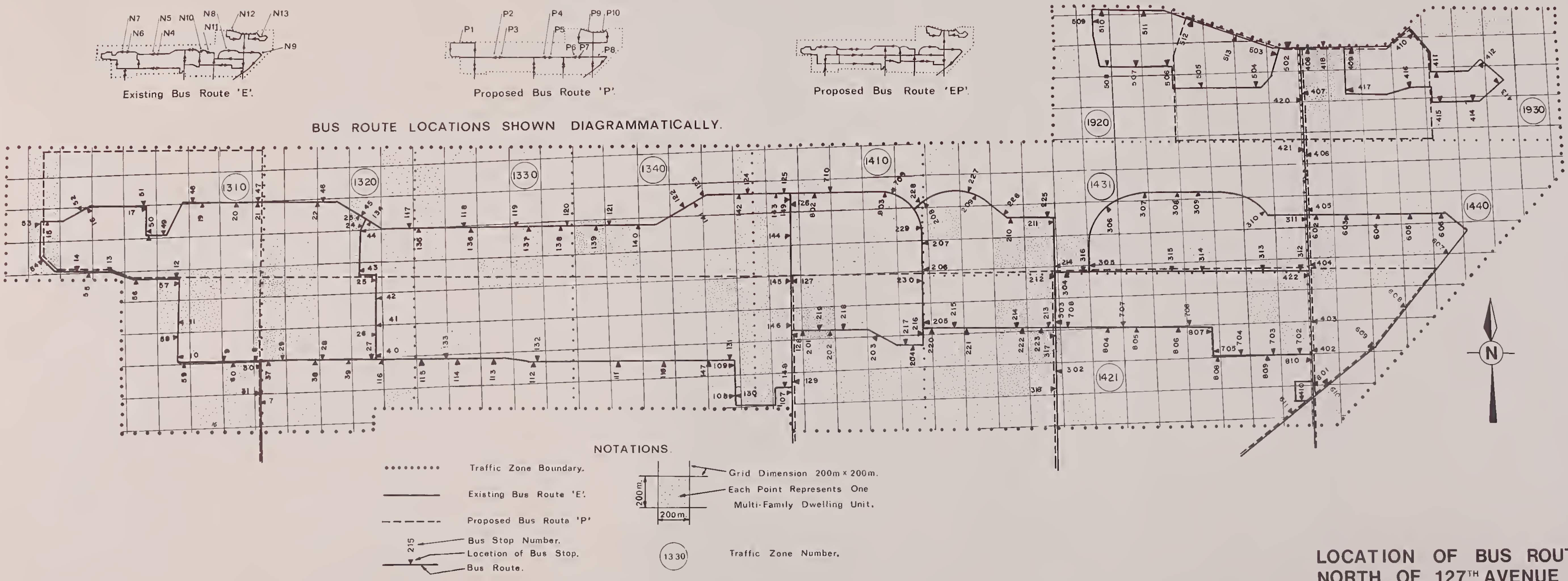


FIGURE E1

LOCATION OF BUS ROUTES NORTH OF 127TH AVENUE IN EDMONTON, ALBERTA.

APPENDIX F

PROGRAM WHICH ANALYSES THE DATA COLLECTED FROM INTERVIEW SURVEY

LISTING OF PROGRAM WHICH ANALYSES DATA COLLECTED FROM INTERVIEW SURVEY

```
C       THIS PROGRAM ANALYSES THE DATA COLLECTED FROM INTERVIEWING PEOPLE
C       WAITING AT BUS STOPS. IT WAS COLLECTED FROM THAT PART OF EDMONTON
C       NORTH OF 127TH AVENUE. ALL THE INFORMATION WAS COLLECTED
C       DURING THE WEEK APRIL 14 TO 18, 1969
        DIMENSION NPROB(10),WHB(40,40),WBW(40,40),WT(40,40),
       1NSEX(40,40),KNOW(40,40),NBR(40,40),NSP(40,40),MF1(100),MF2(100),
       2MF3(100),PTP1(90),PTP2(90),PTP3(90),TITLE1(20),TITLE2(20),
       3TITLE3(20),EOM1(50),EOM2(50),EOM3(50),PE1(50),PE2(50),PE3(50),
       4LL1(90),LU1(90),LL2(90),LU2(90),CPTP1(90),CPTP2(90),CPTP3(90),
       5NXT(40)
        COMMON NC,J(50),U(10),AL1,NTOT,NX
        READ(5,21)(TITLE1(I),TITLE2(I),TITLE3(I),I=1,20)
     21 FORMAT(20A4)
C       READ IN NUMBER OF BUS STOPS AT WHICH PEOPLE WERE INTERVIEWED.
        READ(5,1) NC
      1 FORMAT(I10)
C       READ IN NUMBER OF PEOPLE INTERVIEWED AT EACH BUS STOP.
        READ(5,2)(J(N),N=1,NC)
      2 FORMAT(14I5/4I5)
        READ(5,3)(U(K),K=1,7)
      3 FORMAT(7F10.5)
        READ(5,4)(NPROB(K),K=1,7)
      4 FORMAT(7I5)
        DO 10 N=1,NC
        JJ=J(N)
        DO 10 I=1,JJ
        READ(5,5) WHB(N,I),WBW(N,I),WT(N,I),NSEX(N,I),KNOW(N,I),NBR(N,I)
      5 FORMAT(3F10 1,3I5)
     10 CONTINUE
        CALL STATS (WHB,AVAV1,VAR1,STER1,EOM1,PE1)
        CALL SORT (WHB)
        CALL FREQ1 (WHB,MF1,PTP1,CPTP1,LL1,LU1)
        WRITE(6,51)(TITLE1(I),TITLE2(I),TITLE3(I),I=1,20)
     51 FORMAT("1",24X,20A4/25X,20A4/25X,20A4)
        WRITE(6,52)
     52 FORMAT(//5X,"1    ANALYSIS OF WALKING DISTANCE FROM HOME TO BUS ",
       1"STOP")
        WRITE(6,53) NTOT
     53 FORMAT(/30X,"TOTAL NUMBER OF PEOPLE INTERVIEWED = ",5X,I8)
        WRITE(6,54) AVAV1
     54 FORMAT(30X,"MEAN WALKING DISTANCE TO BUS STOP = ",9X,F10.2)
        WRITE(6,55) VAR1
     55 FORMAT(30X,"THE VARIANCE OF THE COMPLETE SAMPLE = ",9X,F10.2)
        WRITE(6,56) STER1
     56 FORMAT(30X,"THE STANDARD ERROR OF THE COMPLETE SAMPLE = ',F10.2)
        WRITE(6,58)
     58 FORMAT(//5X,"STATISTICAL INTERPRETATION OF DATA COLLECTED")
        WRITE(6,57)
     57 FORMAT(//12X,"ABSOLUTE   PERCENT",/5X,"PROB   ERROR      ERROR",
       1/5X,"(%)",4X,"(FEET)",5X,"(%)")
```

FIGURE F1

```
      DO 20 K=1,7
      WRITE(6,59) NPROB(K),EOM1(K),PE1(K)
   59 FORMAT(/5X,I3,3X,F8.2,6X,F5.2)
   20 CONTINUE
      WRITE(6,60)
   60 FORMAT("1",10X,"SUMMARY OF THE DISTANCES PEOPLE WALKED TO THE",
     1" BUS STOP")
      WRITE(6,61)
   61 FORMAT(/9X,"DISTANCE",20X,"PERCENT OF",4X,"CUMMULATIVE"/9X,
     1"WALKED TO",6X,"NUMBER OF",4X,"TOTAL",9X,"PERCENT OF"/9X,
     2"BUS STOP(FT)",3X,"PEOPLE",7X,"PEOPLE',8X,"TOTAL PEOPLE")
      DO 30 NJ=1,NX
      WRITE(6,62) LL1(NJ),LU1(NJ),MF1(NJ),PTP1(NJ),CPTP1(NJ)
   62 FORMAT(6X,I5,"-",I5,9X,I3,8X,F5.2,8X,F8.2)
   30 CONTINUE
      CALL STATS(WBW,AVAV2,VAR2,STER2,EOM2,PE2)
      CALL SORT (WBW)
      CALL FREQ1 (WBW,MF2,PTP2,CPTP2,LL2,LU2)
      WRITE(6,51)(TITLE1(I),TITLE2(I),TITLE3(I),I=1,20)
      WRITE(6,102)
  102 FORMAT(//5X,"2  ANALYSIS OF WALKING DISTANCE FROM BUS STOP TO ",
     1"WORK")
      WRITE(6,103) NTOT
  103 FORMAT(/15X,"TOTAL NUMBER OF PEOPLE INTERVIEWED = ",6X,I8)
      WRITE (6,104) AVAV2
  104 FORMAT(15X,"MEAN WALKING DISTANCE FROM BUS STOP = ",8X,F10.2)
      WRITE(6,105) VAR2
  105 FORMAT(15X,"THE VARIANCE OF THE COMPLETE SAMPLE = ",10X,F10.2)
      WRITE(6,106) STER2
  106 FORMAT(15X,"THE STANDARD ERROR OF THE COMPLETE SAMPLE = ",F10.2)
      WRITE(6,107)
  107 FORMAT(//5X,"STATISTICAL INTERPRETATION OF DATA COLLECTED")
      WRITE(6,57)
      DO 120 K=1,7
      WRITE(6,108) NPROB(K),EOM2(K),PE2(K)
  108 FORMAT(/6X,I3,3X,F8.2,6X,F5.2)
  120 CONTINUE
      WRITE(6,109)
  109 FORMAT("1",10X,"SUMMARY OF THE DISTANCES PEOPLE WALKED FROM THE ",
     1"BUS STOP")
      WRITE(6,110)
  110 FORMAT(/9X,"DISTANCE",20X,"PERCENT OF",4X,"CUMMULATIVE"/9X,
     1"WALKED FROM",4X,"NUMBER OF",4X,"TOTAL",9X,"PERCENT OF"/9X
     2"BUS STOP(FT)",3X,"PEOPLE",7X,"PEOPLE",8X,"TOTAL PEOPLE")
      DO 130 NJ=1,NX
      WRITE(6,111) LL2(NJ),LU2(NJ),MF2(NJ),PTP2(NJ),CPTP2(NJ)
  111 FORMAT(6X,I5,"-",I5,9X,I3,8X,F5.2,8X,F8.2)
  130 CONTINUE
      CALL STATS (WT,AVAV3,VAR3,STER3,EOM3,PE3)
      CALL SORT (WT)
      CALL FREQ2 (WT,MF3,PTP3,CPTP3)
      WRITE(6,51)(TITLE1(I),TITLE2(I),TITLE3(I),I=1,20)
      WRITE(6,202)
```

```
202 FORMAT(//5X,"3  ANALYSIS OF WAITING TIME")
    WRITE(6,203) NTOT
203 FORMAT(/15X,"TOTAL NUMBER OF PEOPLE INTERVIEWED = ",7X,I8)
    WRITE(6,204) AVAV3
204 FORMAT(15X,"MEAN WAITING TIME = ",24X,F10.2)
    WRITE(6,205) VAR3
205 FORMAT(15X,"THE VARIANCE OF THE COMPLETE SAMPLE = ",6X,F10.2)
    WRITE(6,206) STER3
206 FORMAT(15X,"THE STANDARD ERROR OF THE COMPLETE SAMPLE = ",F10.2)
    WRITE(6,207)
207 FORMAT(//5X,"STATISTICAL INTERPRETATION OF DATA COLLECTED")
    WRITE(6,257)
257 FORMAT(//12X,"ABSOLUTE   PERCENT",/5X,"PROB   ERROR      ERROR",
   1/5X,"(X)",4X,"(MINS)',5X,"(X)")
    DO 220 K=1,7
    WRITE(6,208) NPROB(K),EOM3(K),PE3(K)
208 FORMAT(/5X,I3,5X,F5.2,6X,F5.2)
220 CONTINUE
    WRITE(6,209)
209 FORMAT('1",10X,"SUMMARY OF TIMES PEOPLE WAITED FOR BUS")
    WRITE(6,210)
210 FORMAT(/10X,"TIME",22X,"PERCENT OF",4X,"CUMMULATIVE"/10X,
   1"WAITED FOR",3X,"NUMBER OF",4X,"TOTAL",9X,"PERCENT OF"/10X,
   2"BUS(MIN)",5X,"PEOPLE",7X,"PEOPLE",8X,"TOTAL PEOPLE")
    DO 230 NJ=1,NX
    NXT(NJ)=NJ-1
    WRITE(6,211) NXT(NJ),MF3(NJ),PTP3(NJ),CPTP3(NJ)
211 FORMAT(/9X,I4,12X,I3,8X,F5.2,8X,F8.2)
230 CONTINUE
    IYF=0
    IYM=0
    IFEM=0
    IMALE=0
    DO 300 N=1,NC
    JJ=J(N)
    DO 300 I=1,JJ
    IF(NSEX(N,I).EQ.1) GO TO 250
    IF(NSEX(N,I).EQ.2) GO TO 260
    GO TO 300
250 IFEM=IFEM+1
    IF(KNOW(N,I).EQ.1) GO TO 270
    GO TO 300
270 IYF=IYF+1
    IYEF=(IYF*100)/IFEM
    GO TO 300
260 IMALE=IMALE+1
    IF(KNOW(N,I).EQ.1) GO TO 280
    GO TO 300
280 IYM=IYM+1
    IYEM=(IYM*100)/IMALE
300 CONTINUE
    WRITE(6,51)(TITLE1(I),TITLE2(I),TITLE3(I),I=1,20)
    WRITE(6,401) IFEM
```

```
  401 FORMAT(////15X,"NUMBER OF FEMALES CATCHING BUS = ",8X,I8)
      WRITE(6,402) IMALE
  402 FORMAT(/15X,"NUMBER OF MALES CATCHING BUS = ",10X,I8)
      WRITE(6,403) IYEF
  403 FORMAT(15X,"PERCENTAGE OF FEMALES WHO KNOW TIMETABLE = ",I6,"%")
      WRITE(6,404) IYEM
  404 FORMAT(/15X,"PERCENTAGE OF MALES WHO KNOW TIMETABLE = ",I8,"%")
      IPMF=K(IYF+IYM)*100)/NTOT
      WRITE(6,405) IPMF
  405 FORMAT(/15X,"PERCENT OF ALL PEOPLE WHO KNOW TIMETABLE = ",I6,"%")
      STOP
      END

****** END OF COMPILATION ******
```

```
      SUBROUTINE STATS(X,AVAV,VAR,STER,EØM,PE)
      DIMENSION X(40,40),AVR(50),W(50),AAVR(50),V(50),EØM(10),
     1PE(10)
      COMMON NC,J(50),U(10),AL1,JTE,NX
      JTE=0
      DO 20 N=1,NC
      AV=0
      JJ=J(N)
      AJJ=J(N)
      DO 30 I=1,JJ
      AV=AV+X(N,I)
   30 CONTINUE
      AVR(N)=AV/AJJ
      JTE=JTE+J(N)
   20 CONTINUE
      TE+JTE
      TNC+NC
      AVTE=TE/TNC
      TAV=0
      DO 40 N=1,NC
      AJJ=J(N)
      W(N)=AJJ/AVTE
      AAVR(N)=W(N)*AVR(N)
      TAV=TAV+AAVR(N)
   40 CONTINUE
      AVAV=TAV/TNC
      V1=0
      DO 50 N=1,NC
      V(N)=(AVR(N)-AVAV)**2
      V1=V1+V(N)
   50 CONTINUE
      ANC=NC-1
      VAR=V1/ANC
      STD=VAR**.5
      SVSA=VAR/TE
      STER=SVSA**.5
      DO 60 K=1,7
      EØM(K)=U(K)*STER
      PE(K)=(E M(K)*100.)/AVAV
   60 CONTINUE
      RETURN
      END

****** END OF COMPILATION ******
```

```
      SUBROUTINE SORT(X)
      DIMENSION X(40,40)
      COMMON NC,J(50),U(10),A1,NTOT,NX
      A1=0
      DO 10 N=1,NC
      IF(J(N).EQ.1) GO TO 10
      L=J(N)-1
      DO 10 I=1,L
      JP=J(N)-I
      DO 20 K=1,JP
      IF(X(N,K).GT.X(N,K+1)) GO TO 25
      GO TO 20
   25 TEMP=X(N,K)
      X(N,K)=X(N,K+1)
      X(N,K+1)=TEMP
   20 CONTINUE
   10 CONTINUE
      DO 30 N=1,NC
      JJ-J(N)
      DO 30 I=1,JJ
      IF(X(N,I).GT.A1) A1=X(N,I)
   30 CONTINUE
      RETURN
      END

****** END OF COMPILATION ******
```

```
      SUBROUTINE FREQ1(X,MF,PTP,CPTP,LL,LU)
      DIMENSION NF(40,90),X(40,40),F(90),MF(90),FF(40,90),PTP(90),
     1LL(90),LU(90),RL(90),RU(90),CPTP(90)
      COMMON NC,J(50),U(10),AL1,NTOT,NX
      TE=NTOT
      NX=0
      DO 10 N=1,NC
      DO 10 NT=1,90
      NF(N,NT)=0
   10 CONTINUE
      DO 20 N=1,NC
      JJ=J(N)
      L2=(AL1+100.)/100
      DO 20 NT=1,L2
      TT=NT
      DO 20 I=1,JJ
      RL(NT)=(TT-1.)*100.
      RU(NT)=RL(NT)+100.
      IF(X(N,I).GE.RL(NT).AND.X(N,I).LT.RU(NT)) GO TO 25
      GO TO 20
   25 NF(N,NT)=NF(N,NT)+1
      KK=NT
      KK=KK+1
      IF(KK.GT.NX) NX=KK
   20 CONTINUE
      DO 35 NT=1,L2
      LL(NT)=RL(NT)
      LU(NT)=RU(NT)
   35 CONTINUE
      DO 30 M=1,NX
      F(M)=0
      MF(M)=0
   30 CONTINUE
      DO 40 M=1,NX
      DO 40 N=1,NC
      FF(N,M)=NF(N,M)
   40 CONTINUE
      DO 50 M=1,NX
      DO 50 N=1,NC
      F(M)=F(M)+FF(N,M)
      MF(M)=F(M)
   50 CONTINUE
      DO 45 L=1,NX
      CPTP(L)=0
   45 CONTINUE
      DO 60 M=1,NX
      PTP(M)=(F(M)*100.)/TE
      IF(M.EQ.1) GO TO 57
      GO TO 58
   57 CPTP(M)=PTP(M)
      GO TO 60
   58 ML=M-1
      CPTP(M)=CPTP(ML)+PTP(M)
   60 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE FREQ2(X,MF,PTP,CPTP)
      DIMENSION NF(40,90),X(40,40),F(90),MF(90),FF(40,90),PTP(90),
     1CPTP(90)
      COMMON NC,J(50),U(10),AL1,NTOT,NX
      TE=NTOT
      NX=0
      DO 10 N=1,NC
      DO 10 NT=1,40
      NF(N,NT)=0
   10 CONTINUE
      DO 20 N=1,NC
      JJ=J(N)
      L8=AL1+1
      DO 20 NT=1,L2
      TT=NT-1
      DO 20 I=1,JJ
      IF(X(N,I).EQ.TT) GO TO 25
      GO TO 20
   25 NF(N,NT)=NF(N,NT)+1
      KK=NT
      KK=KK+1
      IF(KK.GT.NX) NX=KK
   20 CONTINUE
      DO 30 M=1,NX
      F(M)=0
      MF(M)=0
   30 CONTINUE
      DO 40 M=1,NX
      DO 40 N=1,NC
      FF(N,M)=NF(N,M)
   40 CONTINUE
      DO 50 M=1,NX
      DO 50 N=1,NC
      F(M)=F(M)+FF(N,M)
      MF(M)=F(M)
   50 CONTINUE
      DO 45 L=1,NX
      CPTP(L)=0
   45 CONTINUE
      DO 60 M=1,NX
      PTP(M)=(F(M)*100.)/TE
      IF(M.EQ.1) GO TO 57
      GO TO 58
   57 CPTP(M)=PTP(M)
      GO TO 60
   58 ML=M-1
      CPTP(M)=CPTP(ML)+PTP(M)
   60 CONTINUE
      RETURN
      END

****** END OF COMPILATION ******
```